Engineering News

VOLUME 72 AUGUST 20, 1914 NUMBER 8

Great Northern Ry. Improvements at Seattle, Wash.

By E. E. Adams*

SYNOPSIS—The Great Northern Ry. line through the northern part of Seattle has been relocated and elevated and all street grade crossings eliminated. A new double-track steel bridge crosses Salmon Bay, and has a 200-ft. bascule span for the channel. The girder spans crossing streets have a concrete-slab deck with ballasted tracks. One of the channel piers was built in a timber crib sunk in place, and having the lower part of the concrete deposited by a tremie.

In connection with the improvement of the Great Northern Ry. between Everett and Seattle, Wash., the line within the city is being improved.† This work consists in replacing the old single-track line by a new double-track location at higher elevation, and building a new bridge over the Salmon Bay Waterway, which forms the west entrance to the U. S. Government canal connecting Puget Sound with Lake Washington. It was provided that : (1) all street crossings should be under or over the new grade; (2) the compensated grade should not exceed 0.4%, with curvature as light as possible; (3) the roadbed should be wide enough for four tracks. The location is shown in Fig. 2.

The city council granted the franchise in June, 1912, and a permit for the crossing of the waterway was secured from the U. S. Government. Construction was undertaken at once, and the work comprised three parts: (1) the new line from Metum (the station at the north city limits) to Interbay, at the head of the company's freight yards; (2) filling the trestles extending two miles from Interbay along the water front; (3) the bridge over Salmon Bay Waterway. The work was under the direction of the engineering department of the Great Northern Ry.: R. Budd, Chief Engineer (now Assistant to the President); Alex. Stewart, Assistant Chief Engineer; O. S. Bowen, Resident Engineer (now principal Assistant Engineer). The writer was Assistant Engineer during construction.

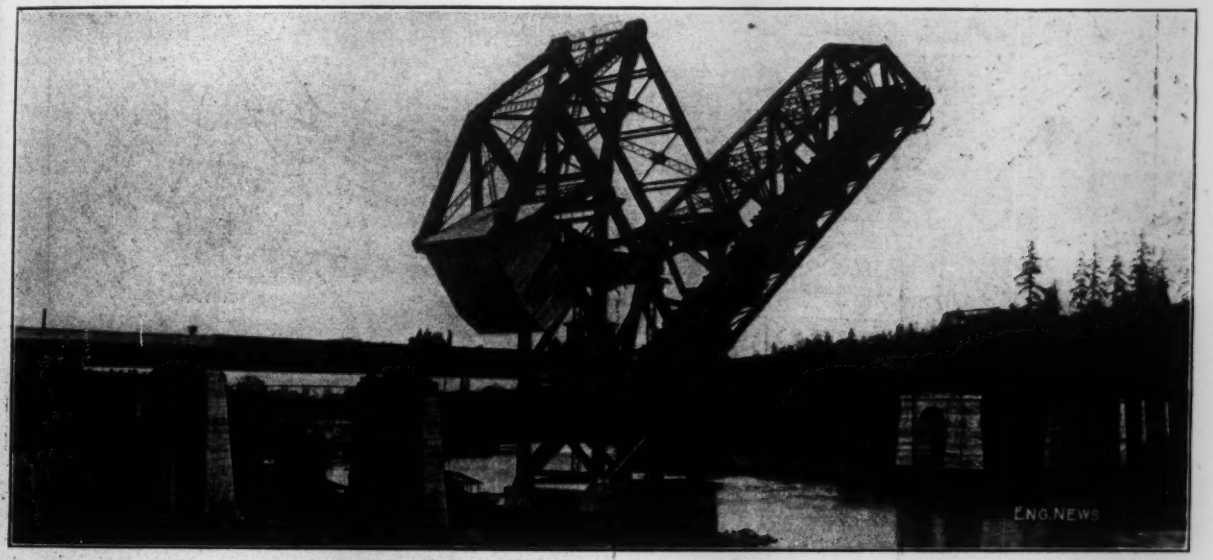


Fig. 1. New Bridge with 200-Ft. Double-Track Bascule Span over the Salmon Bay Waterway at Seattle, Wash.; Great Northern Ry.

(The girder spans at the ends of the bridge have a reinforced-concrete slab deck for ballasted track. The four girder spans nearest the channel have open-floor construction.)

Building the New Line

The work on the north section, from Metum to Salmon Bay, involved rebuilding 2½ miles of track on a new grade of 0.4%. The old track followed a sinuous alignment along the bottom of the high bluffs, and the relocation crossed and recrossed above it at heights up to 23 ft. As the old track was under continuous train movement, it was decided to divert traffic to a temporary track on a pile trestle, one mile long, along the shore; this was parallel to the new track location and along the line of the toe of slope of the new four-track embankment, Fig. 2.

The trestle served to carry traffic during the construction period, and served also as a temporary bulkhead to

†The railway terminals of Seattle were described and illustrated in "Engineering News," Aug. 8, 1912.—Ed.

*Assistant Engineer, Great Northern Ry., Seattle, Wash.

protect the earth embankment from being washed away. The temporary planking of this bulkhead trestle was later reinforced by about 40,000 cu.yd. of riprap rock. The location and grade of the trestle will be maintained and in future the track will serve docks and warehouses along this section of the waterfront. About 310,000 cu. yd. of hardpan and blue clay were moved by a steam shovel, 4-yd. side-dump cars, and small locomotives.

The south section of the line, from Salmon Bay to Interbay, was located through a sparsely settled section of the city, and followed the general contour of a broad flat side hill, the tracks being from 25 to 90 ft. below the surface. All of the streets which were not vacated and those which provide the best channels for street traffic will be carried over the tracks on bridges. In order to eliminate overhead bridges at street crossings not vacated, the railway purchased an additional strip of property and deeded to the city a street or boulevard 100 ft. wide and a mile long, near the top of the slope of the cut and parallel to the tracks. This is shown in Fig. 2 (Gilman Ave. extension), and will form part of a highway to the northwestern part of the city. For this new street, over 30,000 cu.yd. of earth were excavated and deposited on tide flats as filling for new freight yards and terminals.

part of the material excavated from the cut on the s section of the line revision was used in filling these t tles, where at high tide the water reaches a maxi depth of 27 ft. A bulkhead was constructed of p plank, brush and rock to retain the fill. About 100 lin.ft. of piling and 515,000 ft. b.m. of timber were in the construction of the bulkhead, behind which 5 000 cu.yd. of earth fill was placed. The bulkhead reinforced with 12,000 cords of brush and 90,000 cu. of loose rock, delivered on scows from across the Sou By filling the trestles, the railway company eliminate heavy annual maintenance expense and reclaimed acres of land.

Bridge over Salmon Bay

The double-track steel bridge crosses the Salmon Bay Waterway approximately 1000 ft. west of the entrance to the lock of the U. S. Government canal. The channel width is 150 ft., but as the bridge is on a skew (67° 37'), the bascule channel span is 200 ft. long c. to c. of bearings. The base of rail is 65.25 ft. above low water. The bridge, Fig. 1, is 1140 ft. long, with 725 ft. of double-track plate-girder spans; 235 ft. is open-deck construction and 490 ft. (over city streets) is the standard ballasted track section on reinforced-concrete deck slabs with

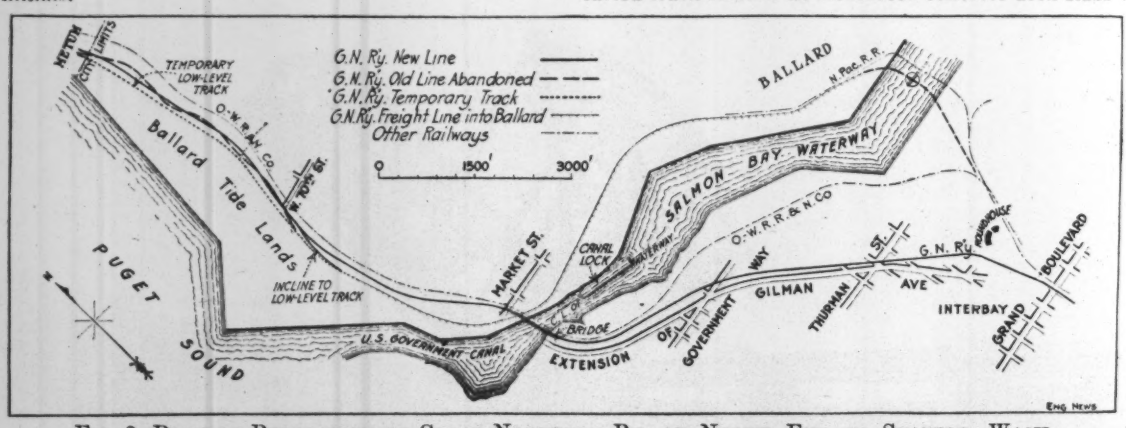


Fig. 2. Plan of Relocation of Great Northern Ry. at North End of Seattle, Wash.

As electric street-car tracks crossed the new line, the railway agreed to relocate those tracks on the new boulevard, which gave them a better grade and a more direct route, and avoided interference with the steam-shovel work. The street-car company has since secured a franchise for continuous operation in the new location.

Temporary bridges were constructed to accommodate street traffic over the cut. These were removed after the cut was completed to grade, and other bridges constructed at the streets which were not vacated. Over 1,250,000 cu.yd. of earth were excavated on the south section, of which 920,000 cu.yd. were taken from the cut for the new tracks. On account of the extreme depth of the cut, the steam shovels worked in tandem, one above the other. This eliminated the danger of slides and facilitated loading the cars. Standard railway equipment was used throughout this section of the work, and conveyed the excavated material from two to six miles through the terminal yards.

Filling the Tide Land Trestles

From Interbay the line follows the Seattle water front for over two miles on creosoted-pile trestles. The greater

curb walls (Fig. 1). The channel is crossed by a 200-ft. Strauss trunnion bascule span, with a 50-ft. girder span at the trunnion end (north), and a riveted-truss through span of 165 ft. at the south end. The steel girder approaches and the 165-ft. truss span were erected in advance of the bascule span, which was assembled and riveted in the open position (83°). This span is operated by two 100-hp. electric motors; it has also a 25-hp. gasoline engine for low-gear auxiliary power, and emergency hand gear.

Bridge Substructure

The substructure comprises 17 piers and two abutments. Piers Nos. 1 to 6 were built first, and then Nos. 11 to 19. The piers in the waterway, Nos. 7 to 10, comprised the third section. Borings indicated blue clay, with pockets of sand and gravel and traces of water; hence concrete piling was specified for the foundations of all land piers and timber piling for the waterway piers. Actual excavation, however, indicated that piling was not required, and all pier footings were redesigned for a total loading of 3 to 4 tons per sq.ft., actual soil tests being carried out for all piers.

The concrete was proportioned 1:3:6 for the footings, and 1:2½:5 for the batter and reinforced portions of the piers. Separate concrete plants were erected for construction of piers 1 to 7 on the south side, and piers 8 to 19 on the north side. In each case the sand and gravel were unloaded from scows and cars by a clam-shell bucket hoist, which delivered it to receiving bins, whence it ran by gravity to the mixers. The concrete was elevated in towers, and distributed by gravity through wood chutes to the different piers, except that for the piers at the extreme ends it was delivered by carts on elevated platforms.

The original specifications provided that the waterway piers should be constructed in open coffer-dams, but the bids on this feature showed that for Pier No. 7 (the pier carrying the truss span and the movable end of the bascule) a great saving could be made by using some other method. The method adopted consisted of preparing and sinking a timber crib for the base of the pier and depositing the concrete through a tremie up to an elevation of 4 ft. below low water. The crib was constructed in the water, floating at the site of its permanent location, where a dipper dredge had previously located the pocket for the pier base to a depth of 50 ft. below high water (7 ft. below the ultimate bottom of the canal).

The crib was 25x70 ft., and 53 ft. high. Extreme care was exercised in fastening the timbers so as to form one unit. It was divided into four sections with cross timbers spaced 4 to 6 ft. apart. The horizontal timbers were bolted to the vertical timbers which anchored the whole crib and provided against separation due to flotation. On account of a tidal range of 18 ft., it was difficult to keep the crib properly balanced and anchored; twice it tipped on its side and had to be righted.

The completed crib was sunk into place during low tide by loading it with steel rails placed in pockets or racks on the outside. On account of the slightly uneven bottom, the crib did not rest in a perpendicular position after being sunk, and as the cutting edge had no effect on the hard subsoil this was removed by a sea diver who succeeded in bringing the crib to within 6 in. of being truly perpendicular on the longitudinal axis.

The tremie was of heavy 10-in. wrought-iron flange-connected pipe, and was made in sections so that it could be shortened as the concrete mass increased in depth within the crib. The concrete was delivered to the tremie by a gravity chute, which greatly facilitated the work. A total of about 1400 cu.yd. of concrete was delivered to the crib in a continuous mix. The charge in the tremie was lost only when the tremie was lifted from one section of the crib to another. The concrete was made rich with cement (1:1.75:3.47), and the gravel aggregate was a fine grade. No coarse gravel was allowed and this seemed to result in a good steady flow through the tremie.

In order to dry the upper portion of the crib, clean the top concrete and prepare for the upper form work, the old method of inclosing the crib with canvas was used with success, after several other methods of calking the seams, etc., had been tried. After the canvas was placed around the crib, two centrifugal pumps (8 in. and 6 in.) kept the interior of the crib dry and the balance of the concrete was placed in the open. This pier is shown in Fig. 3.

The two smaller piers on the north side of the waterway (carrying the tower at the trunnion end of the bascule) were so located that a coffer-dam could be constructed around them and the work carried on in the open. Round piling constituted the outside and inside stiffeners. Wakefield sheet piling was then driven within this and tied with steel rods and the whole interior filled with earth. Within the dam, 4x8 in. sheet piling was driven to prevent the earth from sliding into the pier pits. The bracing was of 10x10-in. timbers, placed in tiers about 4 ft. apart as the excavation progressed.

At high tide, the water reached a maximum depth of about 27 ft., thus subjecting the dam to alternate stresses, which would not allow the core of the dam to become set or hardened. A very disastrous blowout occurred at one of these periods and the whole work within the dam was submerged. After the dam was repaired the excavation was retarded by the great amount of silt which had entered at the time of the blow-out. A unique method of

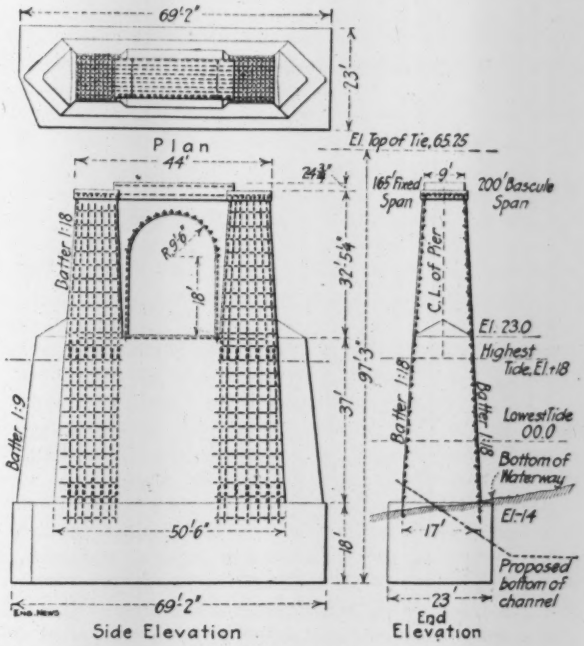


FIG. 3. REINFORCED-CONCRETE REST PIER OF THE BRIDGE OVER THE SALMON BAY WATERWAY; GREAT NORTHERN RY.

draining the water from the silt and mud consisted in sinking two wells on each side of the inside area. The water was then drawn from the wells by the centrifugal pumps and the excavation continued in the dry. At a depth of 50 ft. below high tide, the excavation was stopped, and the concrete was delivered through long wooden chutes to the forms built within the dam.

A total of 10,861 cu.yd. of concrete was placed in the substructure of the bridge, the railway company furnishing all the cement. A total of 17,888 cu.yd. of earth was excavated for the piers and abutments; 6065 yd. of this was included in the lump sum bid of preparing the three waterway piers for concrete, the balance being paid for as dry and wet excavation. The substructure was completed in 13 months by the Butler Construction Co., of Seattle.

Undergraduate Instruction in Highway Engineering

By T. R. Agg*

In attempting to outline collegiate work in highway engineering it is well to consider what kinds of things a graduate ought to know about highway work in order to become a useful member of the profession; and as many of those subjects deemed important should be taught as time and equipment will permit.

The conditions under which a college graduate will work when he first secures a position are exceedingly diverse in the various parts of the United States and the kind of specialized training in highway engineering that might fit a student admirably to take up the work in one state might not be so advantageous to him elsewhere. It would seem then that a training in highway work should first include those things which are in the nature of basic principles and generalities rather than those things which are matters of detail.

Ethical Standards—The graduate should first of all realize that throughout his career he will deal with the public and with public officials. In his relation to the public he may become a leader or exemplar of the ideals of public service, which are economy and efficiency. He may drift along without giving offense to anybody and without accomplishing anything progressive; or he may ally himself with some political faction and conduct all work assigned to him in accordance with the well known principles of partisan politics rather than those of highway engineering.

No subject can be introduced into the technical training of the student that will have any particular bearing on the ethical standards which he sets up for himself. But the members of faculties have an unsurpassed opportunity to instill by personal contact the broad principles of professional integrity and a realization of the dignity and honor that may accrue from public service.

Highway Economics—The financing of highway and pavement construction involving as it does important economic principles, deserves a place in highway engineering instruction. Because of the ever increasing taxes which are levied for public improvements the time will come when engineers will be compelled to justify proposed expenditures by arguments which are economically sound.

The choice of type of construction, the methods of financing and the system of administration and maintenance are inextricably merged, and the bearing of each on any problem can be rightly determined only when the principles of economics and efficiency are applied. The basic principles of highway economics are comparatively few and may readily be given as supplementary to the work in general economics, which is included in many 4-year engineering courses.

Organization and Administration—The trend of highway administration is toward centralized authority such as is vested in County, State and National Commissions or Departments; and there is reason to believe that this tendency will be extended to include paving of cities and the performance of other public works. Such a development seems inevitable if the administration of highway work continues to increase in efficiency and to substitute sound engineering and economic principles for p[o]l[i]cal chicanery in the building of highway struc[t]s. Highway engineering should, therefore, include a [s]y of the methods of highway administration in effect i[n] the United States and abroad and a comparison of the [q]ity and cost of the roads produced by them, and o[f] the safeguards thrown about the expenditures of p[u]blic money in the various systems.

Roads, Pavements and Highway Bridges—The highway engineer should have a thorough knowledge of all of the types of the structures which he may be called upon to build, that is, of roads, pavements and highway bridges. The student should learn the history and the characteristics of each type, and the conditions of service for which each is adapted. He should know the underlying principles involved in the selection of a particular type for use under a known set of conditions. Many colleges now offer a course in roads and pavements that meets this requirement, or that could readily be modified to meet the needs of men who are preparing for highway work.

Surveys and Plans—The implements with which the highway engineer works are plans and specifications and the making of surveys is of course a prerequisite to the preparation of plans. The surveys for road and pavement plans do not involve any principle beyond those taught in courses in surveying in all colleges of good standing. Differences in the details of the methods of making the surveys are numerous, but these are usually easily and quickly mastered, and can readily be adapted to the requirements of different state and county authorities. It is a waste of time to attempt to teach the many special methods of making highway surveys to students in highway engineering.

The average plan prepared for highway or pavement construction, however, leaves much to be desired in the interest of completeness and clearness. The preparation of the plans involves the application of correct principles of highway design. It is believed that a course prepared in such a way as to emphasize the principles of correct design and the importance of complete and easily interpreted plans could properly be given to students in highway engineering.

Contracts and Specifications—A contract to build a highway structure or a pavement is a bargain between an individual or corporation and the public, the terms of which are set forth in the specifications. It follows then that these conditions should be set forth in clear and unequivocal English, that they should be concise and complete and be free from ambiguity, yet be drawn with a full understanding of the difficulty of anticipating all conditions, and therefore, providing for an equitable adjustment of all unforeseen contingencies. A course in highway specifications is an excellent adjunct to a course in roads and pavements because of the emphasis the writing of specifications puts upon each step in the construction.

Specifications for pavements are often drawn by attorneys rather than by engineers, or, they are copied from other specifications which have been in use. There is no valid reason why this should be true except that engineers have not given sufficient time or attention to the study of contracts and specifications. A course in the preparation of contracts and specifications for road and pavement work is, therefore, advisable as a part of the training for

*Professor in charge of highway engineering, Iowa State College, Ames, Iowa.

highway engineering. In many cases this work could be substituted for the general course in contracts that is usually given in engineering schools and thus avoid duplication.

NONBITUMINOUS ROAD MATERIAL TESTING—That the highway engineer should have a thorough knowledge of the materials used in construction and of the methods of testing and the significance of the results of tests is evident. Although much work remains to be done before all of the various tests for road materials will be standardized, there is now sufficient knowledge on the subject to warrant the introduction of a course in nonbituminous materials testing in a course in highway engineering.

BITUMINOUS MATERIALS TESTING—The very rapid development of bituminous road and pavement construction and the probability of a continued increase in the amount of this type of pavements makes it imperative to give some practice in bituminous materials testing. As with nonbituminous materials, much work remains to be done before all tests for bituminous materials can be standardized, yet sufficient knowledge and experience has been gained to enable the engineer to determine by suitable tests, with a fair degree of certainty, the value of any material submitted to him. In this work experience is of the utmost value, but if the routine tests are taught to the student, and he goes into the field of bituminous construction, he will rapidly learn to correlate the results of tests with the behavior of the materials in service.

DEVELOPMENT OF COURSES IN HIGHWAY WORK

There are two general methods that may be followed in the development of highway engineering, one being to give a 4-year course in highway engineering, the other being to permit students in civil engineering to take special work in highway engineering during the junior and senior years.

If a 4-year course is built around the instruction in highway engineering it will certainly be desirable to give during the first two years some of the usual general subjects if the student is to achieve the mental development necessary for a broad career. The last two years way engineering to the exclusion of such subjects as might be devoted very largely to subjects related to highway engineering to the exclusion of such subjects as water-supply, sewers, sanitation and general structures. Sufficient time would thus be available to cover practically the entire field of knowledge relative to highway construction.

If the option method were followed it would only be possible to teach the student where the facts in regard to highway construction may be obtained, how they may be used, and the general principles and the experience which are behind these facts. He could be taught to analyze a specific problem or situation in accordance with the recorded knowledge of highway engineering, and to find the solution, and to know when he had the correct one. A course of this kind necessitates spending much time in the study of mathematics, chemistry, physics, mechanics and allied subjects which are essential to the development of clear thinking and reasoning ability, and to the analysis and solution of problems.

If a course in highway engineering is developed along this line it simply involves substituting in the junior and senior years in the ordinary civil-engineering course a few subjects directly related to highway engineering. These subjects, in general, would displace other subjects of no greater value as general training. This procedure has the invaluable advantage of detracting but little from the possibility of a student's getting into other lines of engineering, if the field of highway engineering does not suit him, or if he fails to find his place therein.

The average undergraduate student has no clearly defined ideas as to what kind of work he wants to do after graduation, and many things may develop during his college years to change his ideas as to his future career. The college ought, therefore, to do everything possible to make well developed, clear thinking men, at the same time giving some practical preparation that can be used upon graduation to insure bread and butter while the man is finding himself.

The factors which make for success in the field of highway engineering are not primarily high scholastic attainments and great technical ability, although the more of these the man has the better, so long as some other things are included in his make-up. Ability to meet men of all classes, to deal harmoniously with other public officials and to address public meetings, coupled with a keen appreciation of the responsibilities and opportunities of public service are qualifications which weigh heavily in favor of the man who enters the field of highway engineering. If to these qualities is added a thorough training in the fundamental principles and practices of the profession of highway engineering, the graduate should be able to find an opportunity for a broad career in highway work.

It is suggested that the following subjects might be inserted in the junior and senior years of the ordinary civil-engineering course and thus give about all the desirable undergraduate instruction in highway engineering, and at the same time displace few studies of any more general value as mental training:

(1) HIGHWAY ECONOMICS—Second semester junior year, two credit hours. A study of the relation of highway improvement to the economic welfare; the principles of taxation for public improvements; and of financing road and pavement construction.

(2) ROAD AND PAVEMENT SPECIFICATIONS—First semester senior year, two credit hours. A study of the basic principles of specifications, and of the details of form and wording. This might be supplementary to the course in contracts and specifications often given in engineering courses.

(3) ROADS AND PAVEMENTS—First semester senior year, two or three credit hours. A study of the types of roads and pavements, methods of constructing them, and their relative values under varying conditions of service. This could be an adaptation of the usual course in roads and pavements, or, in many cases, the course in roads and pavements already being given would suffice.

(4) NONBITUMINOUS MATERIALS LABORATORY—First semester senior year, one credit hour. A study of the methods of testing nonbituminous road materials and of the significance of the results of tests.

(5) HIGHWAY ADMINISTRATION—Second semester senior year, two credit hours. A study of the methods of organization and administration for highway construction, including systems of maintenance.

(6) ROAD AND PAVEMENT DESIGN—Second semester senior year, three credit hours. A study of the principles of design of roads and pavements, exercises in the preparation of plans and estimates for road and pavement construction.

(7) BITUMINOUS ROAD MATERIALS LABORATORY—Second semester senior year, one credit hour. A study of the usual tests for bituminous road materials and of the application and significance of these tests.

(8) DESIGN OF HIGHWAY BRIDGES—Second semester senior year, two credit hours. A study of the design of the various types of highway bridges and culverts. This might well be given in connection with the course in structural engineering.

A Rating Chart for Centrifugal Pumps

By L. J. Bradford*

When an order for a centrifugal pump is given, usually the conditions under which the pump is to operate are stated and the selection of the pump to meet these conditions is left to the makers. The manufacturer's engineer makes his selection by reference to a rating chart which shows the performances of various stock pumps carried.

The purpose of this article is to show how to lay out and use a graphical rating table which greatly facilitates the selection of a pump when the required speed, head and capacity are given. The chart is in reality a collection of speed-capacity characteristics of all the pumps of a given line, each operating at unit head, and over a certain range of efficiencies. It is usually laid out for one stage, but can easily be constructed for any number of stages. In this article only the chart for single-stages will be dealt with.

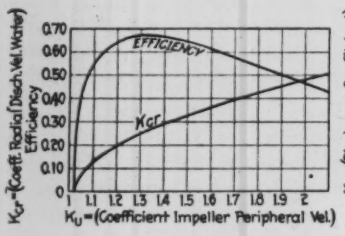


Fig. 1

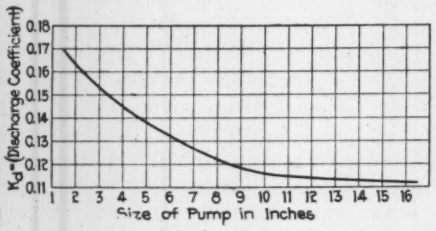


Fig. 2

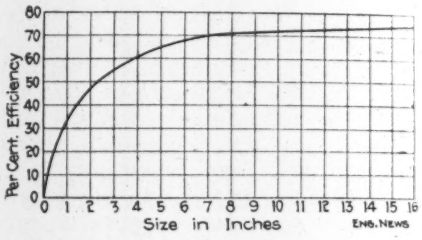


Fig. 4

Before taking up the method of laying out the chart, it is necessary to call attention to the peculiar characteristic curve upon which it is based. Fig. 1 shows this. Unlike the ordinary performance curves, it is not drawn with head and capacity for coördinates, but with coefficients of peripheral velocity of the impeller and of radial exit velocity of the water. These coefficients are derived as follows:

$$K_u = \text{coeff. peripheral vel.} = \frac{U_2}{\sqrt{2gh}} \qquad (1)$$

$$K_{cr} = \text{coef. radial exit vel.} = \frac{V_{ra}}{\sqrt{2gh}} \qquad (2)$$

U_2 = peripheral velocity of outside of vanes in feet per second;
V_{ra} = radial velocity in feet per second of water leaving impeller;
h = head per stage developed by pump;
g = acceleration due to gravity = 32.2 ft. per sec. per sec.

The coefficient K_u is the ratio of the actual speed of the impeller to the theoretical velocity of the water necessary to produce the head h. It may be either greater or less than unity, and depends largely upon the angle which the tangent to the vane makes with the tangent to the outside of the impeller. In general, a forward curving vane will give a value of K_u less than unity, a radial vane unity, and a backward curving vane greater than unity. The coefficient K_{cr} also depends to a certain extent on this angle.

*Instructor in Machine Design, Sibley College, Cornell University, Ithaca, N. Y.

When a new line of pumps is to be designed, a p... having the desired shape of characteristic is tested, the "K_u — K_{cr}" characteristic is plotted as shown in 1. Next, the values of the coefficient of discharge vel... for the various sizes of pumps to be made are assu... The values of these discharge coefficients,

$$K_d = \frac{V_d}{\sqrt{2gh}}$$

where V_d = velocity of water in the discharge pipe ... feet per second, are such as former experience has sho... to give good results. Fig. 2 shows graphically how ... values of the discharge coefficient may vary with the s... of the pump. Having assumed the discharge coefficien... the capacity of a pump for a unit head can be computed. The following notation will be used:

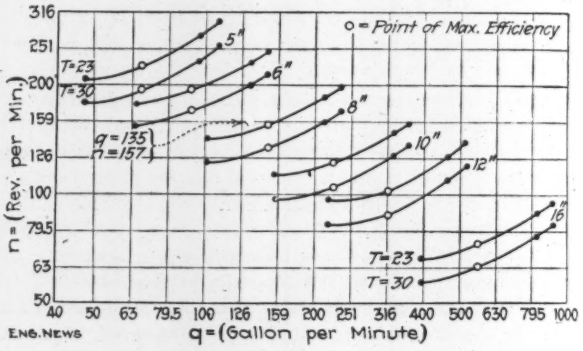


Fig. 3

Q = pump capacity, cubic feet per second;
N = r.p.m.;

$$K_d = \text{discharge coefficient} = \frac{V_d}{\sqrt{2gh}} \qquad (3)$$

d = diameter of discharge, inches;
h = head per stage;
A = area of discharge, square feet, $= \frac{0.7854\,d^2}{144}$;
q = capacity of pump at unit head $= \frac{gal.\,per\,min.}{\sqrt{h}}$
n = speed of pump at unit head $= \frac{r.p.m.}{\sqrt{h}}$;
D_2 = outside diameter of vanes, inches;
W_2 = width of impeller passage at exit;
T = type of impeller $= \frac{D_2}{W_2}$; (4)

Now

$$Q = \frac{q\sqrt{h} \times 231}{1728 \times 60} \qquad (5)$$

Also $V_d = \frac{Q}{A}$, and by substitution,

$$V_d = \frac{q\sqrt{h} \times 231 \times 144}{1728 \times 60 \times 0.7854\, d^2} \qquad (6)$$

or by dividing both sides of this equation by $\sqrt{2gh}$, simplifying and remembering that $K_d = \frac{V_d}{\sqrt{2gh}}$ we get

$$K_d = \frac{q}{19.6\, d^2} \text{ or } q = 19.6\, K_d \cdot d^2 \qquad (I)$$

From this equation the value of the discharge at unit head, or, as it is more frequently called, the "unit capacity," may be computed as soon as values are assigned to K_d and d. The speed in feet per second at unit head, or "unit speed," is found as follows:

$$K_u = \frac{\pi D_2 N}{60 \times 12 \times \sqrt{2gh}} \therefore N = \frac{K_u \times 12 \times \sqrt{2gh} \times 60}{3.14 \times D_2}$$

Dividing by $\sqrt{h}$ and reducing,

$$n = \frac{K_u \times 1840}{D_2} \qquad (7)$$

Were the values of K_u and D_2 known, the chart could now be laid out. But D_2 is usually unknown unless the chart is being drawn for an existing line of pumps. Of course D_2 could be assumed, but it is usually preferable to assume the type T of the impeller.

Assuming that 85% of the total area of the periphery of the impeller is available for the passage of water, we have

$$W_2 = \frac{gal.\ per\ min. \times 231}{V_{ra} \times 12 \times 60 \times \pi D_2 \times 0.85}$$

Dividing the numerator and denominator on the right by $\sqrt{h}$

$$W_2 = \frac{0.015\, q}{K_{cr} \cdot D_2} \qquad (8)$$

Substituting $\frac{D_2}{T}$ for W_2,

$$D_2 = \sqrt{\frac{0.015\, q\, T}{K_{cr}}}$$

Placing this value for D_2 in equation (7) there results,

$$n = \frac{15{,}025\, K_u \sqrt{K_{cr}}}{\sqrt{q\, T}} \qquad (II)$$

Values for q and n may be obtained for any size of pump using any type of impeller, the values of K_u and K_{cr} being taken from the test on which the line is based. Four values of q and n are usually computed for each impeller represented. The points usually taken are the point of maximum efficiency, 90% of maximum efficiency—at a capacity lower than that at which maximum efficiency is reached, and 95% and 90% of maximum efficiency—at greater capacities than for maximum efficiency.

Application

The use of these formulas can best be made clear by sample computations. Take for example the case of a 6-in. pump.

d = 6 in.;
K_d = 0.132 (based on tests of existing pumps which give good efficiency. See Fig. 2);
T = 23 (assumed);
K_u = 1.25 (from test, see Fig. 1 and Eq. 1);
K_{cr} = 0.22 (from test, see Fig. 1 and Eq. 2);
Maximum efficiency = 67% (from test, see Fig. 1).

Calculation of q and n for 100% of Maximum Efficiency

$$q = 19.6 \times 0.132 \times 6 \times 6 = 93 \qquad \text{(from Eq. I)}$$

$$n = \frac{15{,}020 \times 1.25 \times 0.47}{46.2} = 192 \qquad \text{(from Eq. II)}$$

Calculation of Other Than the Point of Maximum Efficiency

Since K_u and K_{cr} are respectively directly proportional to the peripheral velocity of the impeller and the radial velocity of the water, it follows that n and q are, for a given pump, directly proportional to K_u and K_{cr}, respecttively. If, therefore, it is desired to find the values of q and n with the pump operating at other than maximum efficiency, it is necessary only to write the following equations and solve.

$$n_x = \frac{n_{100} \times K_{ux}}{K_{u_{100}}} \qquad (III)$$

$$q_x = \frac{q_{100} \times K_{crx}}{K_{cr_{100}}} \qquad (IV)$$

If it is desired to find the values of q and n when the pump is operating at 90% of its maximum efficiency, and delivering less water than it would at maximum efficiency,

$$efficiency = 0.90 \times 0.67 = 0.603$$

By reference to the impeller-velocity characteristic (Fig. 1), it is seen that the values of K_u and K_{cr} corresponding to an efficiency of 60.3% and a minimum discharge are $K_u = 1.15$ and $K_{cr} = 0.155$. Substituting in equations III and IV,

$$n_{90} = \frac{192 \times 1.15}{1.25} = 177 \qquad q_{90} = \frac{93 \times 0.155}{0.22} = 65.5$$

The points on the front of the curve, that is when the pump is discharging more than its normal amount of water, are found in a similar manner. Fig. 3 shows such a chart plotted on logarithmic paper for a complete line of pumps, sizes varying from 5 to 16 in., and for two types of impeller for each size.

Use of Chart—When an order for a pump is received the values of q and n are immediately calculated from the conditions of operation, by means of the equations $q = \frac{gal.\ per\ min.}{\sqrt{h}}$ and $n = \frac{r.p.m.}{\sqrt{h}}$, and the point plotted. The impeller having the next value of n below that found is taken, and if the difference is large the tips of the vanes are cut back. (This is done to bring the speed up to that required. It is readily seen that cutting back the vanes increases the speed when it is remembered that for any given impeller the outside diameter of the vanes must attain a certain peripheral velocity in order to produce a certain head.)

Suppose, for example, that an order came in for a pump to deliver 1500 gal. per min. against a head of 250 ft. when running at a speed of 1760 r.p.m. The pump will obviously consist of two stages, for while a head of 250 ft. per stage is possible, it can usually be attained only at the sacrifice of efficiency. The head per stage is then 125 ft.

$$q = \frac{1500}{\sqrt{125}} = 135 \qquad n = \frac{1760}{\sqrt{125}} = 157$$

The point determined by these values of q and n is then plotted as shown on Fig. 3. The impeller chosen will be the one having the next highest values of q and n. In this case an 8-in. pump having a type 23 impeller would be chosen and the vanes cut back a trifle. The pump would operate at about 98% of its maximum efficiency. From Fig. 4, it is seen that the maximum efficiency of an 8-in. pump operating at 125 ft. per stage is 71%. The efficiency of the pump selected would therefore be about $71\% \times 0.98 = 69.5\%$.

Moving Sand by Pumping*

A pump without pistons or plungers, especially designed for pumping sand or fine coal, was recently placed on the market. The operation is simple. The steam is introduced into one cylinder at a time, forcing out its contents. The vacuum in one cylinder and the pressure in the other, forces over the steam-control valve. The steam by this operation is introduced into the chamber just filled with the pumped mixture. The steam operation involves no mechanical parts and the only moving element is the steam valve, which has a movement of about 5/8 in. The valves are either of the ball or flat type. Balls are used for the discharge valves and in some cases for the suction. The balls are usually of rubber; the flat valves are always of rubber.

The pump is claimed to have a very high vacuum and hence a strong suction, which, of course, is very necessary in sand pumping. The pump was patented in 1909 and placed on the market at that time, but it was not adapted for pumping sand until recently. It is claimed that a mixture of at least 35 or 40% sand can be easily handled. Wherever the sand comes in contact with [illegible] or elbows, the pump is heavily reinforced; parts [illegible] casting are 2 in. thick. This pump can also be [illegible] handling fine coal or crushed rock. The pump [illegible] by the Nye Steam Pump & Machinery Co., 701 [illegible] western Ave., Chicago, Ill.

An Installation

The accompanying views show the pump in action at Fern, Ind., at the sand mine of the Root Glass Co. Until the pumps are installed, the mine was operated by numerous belt conveyors, and by sand-washing screens. By this familiar method, a certain amount of the sand washed was carried off by the water and lost. Traveling belts were costly to replace and wore rapidly.

At the mine, rock is reduced by blasting to about 70% sand. This sand is washed to a sump pit, located in the center of the mine, by means of water jets and is then picked up by a 4-in. pump (5-in. suction and a 4-in. discharge) and discharged upon separating screens. Sand is then washed down to a sump in the building, located under a 5-in. pump (6-in. suction and a 5-in. discharge).

Fig. 1. Pump in Old Sand-Settling Basin

(Basin was to be shifted, so pump was installed temporarily to remove the storage sand.)

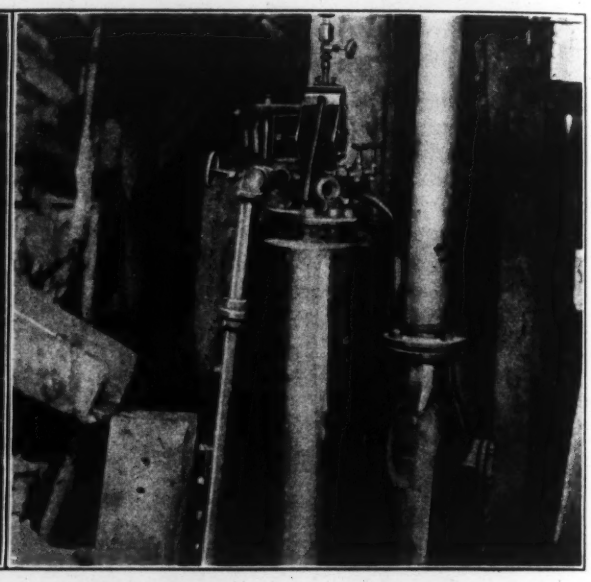


Fig. 2. No. 5 Pump, Fern, Ind.

(All sand shipped from this mine passes through the pump shown.)

The rock at the mine, not broken up by the blast, is placed in a crusher, from which it falls into a sump, located under another 4-in. pump. The discharge of this pump with that of the first-mentioned pump is carried into the sump under the 5-in. pump. In this way, the latter pump handles all the sand to be shipped, elevating it vertically 35 ft. and horizontally 60 ft. to the cars where it empties into a sand-and-water separator, which automatically opens and closes as the sand deposits in its bottom. The water in the separator rises to the top, runs over and is carried off by piping.

Not only is the sand conveyed, through the action of the pump, but it is thoroughly scrubbed in its passage through it.

It is claimed that the installation of the pump raised

*Arranged from information furnished by the Nye Steam Pump & Machinery Co.

the average production of this mine from 120 tons per day to 450 tons, and that whereas the cost of production by the old method was $2 per ton, the pumping method cost but 57c. per ton.

New Locomotive Terminal of the Central R.R. of New Jersey

The large new locomotive terminal of the Central R.R. of New Jersey, at Communipaw, N. J., is one of the principal features of the reconstruction of the passenger terminal at Jersey City, N. J., described in ENGINEERING NEWS, of July 30, 1914, p. 238. The locomotive terminal is located on the south side of the main-line tracks, about one mile west of the passenger terminal, and is in close proximity to the freight yards on the opposite side. It consists of two roundhouses governed by two connecting 100-ft. turntables. The number of locomotives handled per day in summer averages about 300, which includes all the usual performances of a terminal character, e.g., cleaning fires, dumping ashes, coaling, supplying sand and water, washing boilers, and inspecting, together with any light running repairs which may be necessary. The trackage of the locomotive terminal amounts to about 11 miles.

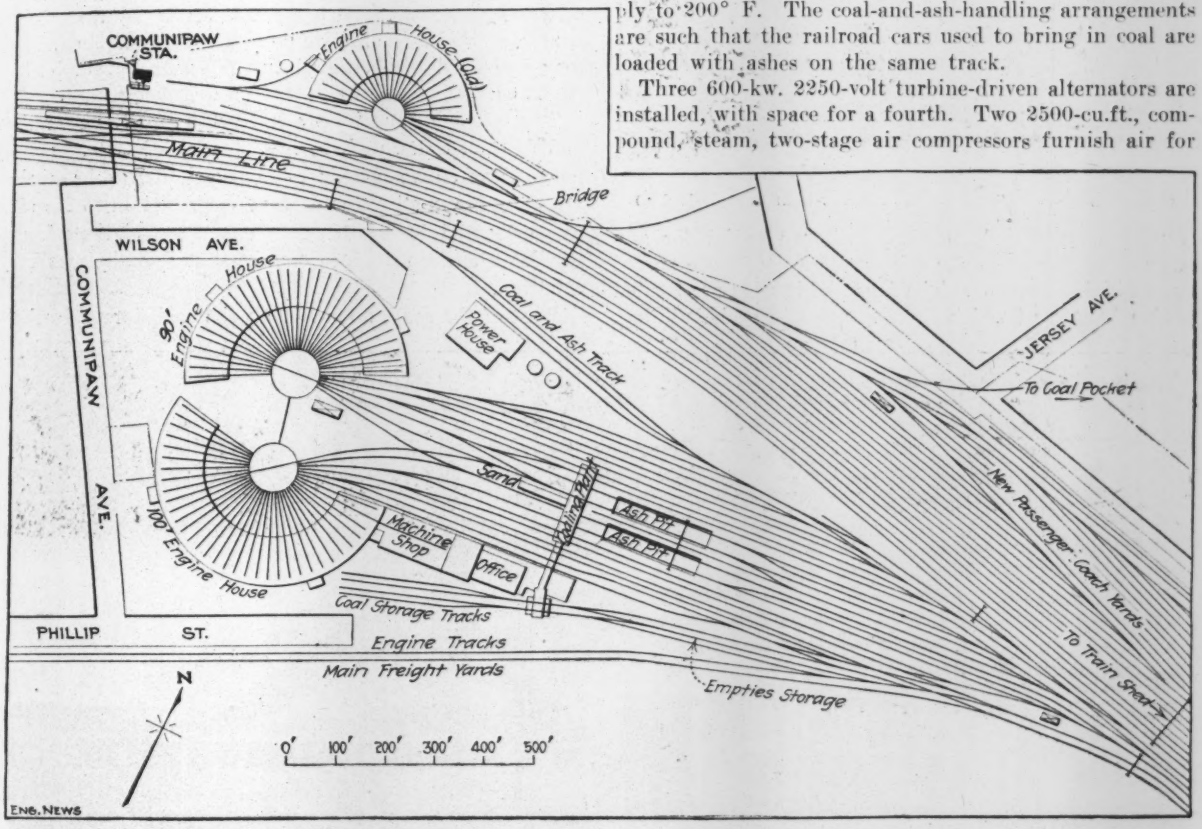


FIG. 1. GENERAL LAYOUT OF LOCOMOTIVE TERMINAL OF CENTRAL R.R. OF NEW JERSEY

The soil is principally of cinder fill varying in depth from 2 to 10 ft. on blue clay, sand and bog. In consequence, all the buildings rest on piles, except the west half of one of the roundhouses, where the ground conditions are favorable for masonry footings. The foundations consist of timber piles and concrete piers where the concentrated loads are imposed, with reinforced-concrete wall girders supporting the building walls. The power house, which is in this group of buildings, rests on a concrete slab 4 ft. thick, extending under the entire building, which in turn is supported on piles equally spaced. All the buildings are constructed of reinforced concrete, steel and brick, with steel sash and concrete floors. The roofs are covered with 3-ply built-up asbestos-felt and asphalt roofing.

POWER HOUSE—The power house, which furnishes power for lamps and motors throughout the terminal, is 125x92 ft. in plan. Six 250-hp. water-tube boilers arranged in three batteries of two each are installed; while space is provided for an additional battery. Automatic stokers are used. Draft is obtained with a 100-ft. steel stack and two turbine-driven blowers. Looped feed-water and steam lines are used. An open feed-water heater takes the exhaust of auxiliaries and raises the boiler supply to 200° F. The coal-and-ash-handling arrangements are such that the railroad cars used to bring in coal are loaded with ashes on the same track.

Three 600-kw. 2250-volt turbine-driven alternators are installed, with space for a fourth. Two 2500-cu.ft., compound, steam, two-stage air compressors furnish air for the engine terminal and for the interlocking system. The main control board is located on the engine-room floor, with the high-tension switches in the basement, with the transformers. High-tension current is led to a service substation near the passenger terminal and stepped down to 550, 220 and 110 volts. The lower voltages for use near the power station are secured from transformers in the basement.

ROUNDHOUSES—The two roundhouses—one 34-stall, 100-ft. and one 32-stall, 90-ft.—are constructed with reinforced-concrete piers, columns and roof girders, with

hollow-tile and concrete roofs. The rear wall consists of concrete piers approximately 5 ft. wide with steel sash between. This arrangement permits of a maximum window space, both for lighting and ventilation. A row of hinged sash is provided over each stall. There are other ventilating features as well, which provide an outlet for any gases collecting under the ceiling. Both houses are heated by the indirect system. The fans and heaters are located in fan houses, of which there are two in each building.

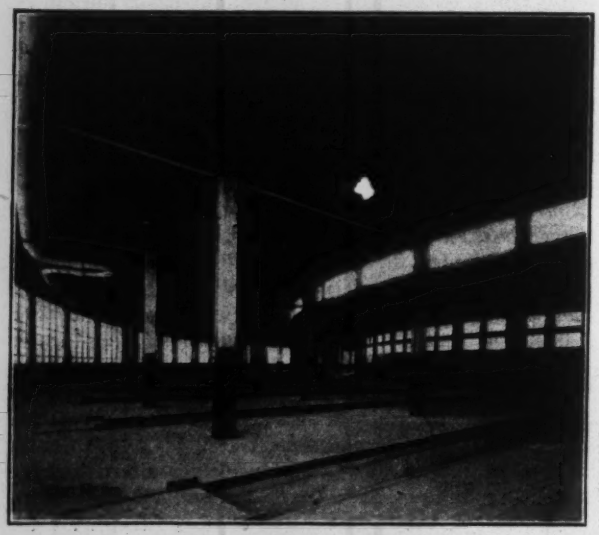


FIG. 2. INTERIOR OF ONE OF THE TWO ROUNDHOUSES
(Showing inspection pits and asbestos-board smokejacks.)

The hot air is delivered through underground ducts and discharged through outlets located in the pits and around the rear wall. The floor wearing surfaces are concrete throughout and reinforced along the sides of the pits to provide bearing for jacking.

The entrance doors to the stalls are hinged to plinth posts which are entirely separate from the building construction proper, and so fastened to the building columns that the accidental wrecking of a door will not damage the building structure.

TURNTABLES—Each roundhouse is served with a 100-ft. turntable of heavy construction, operated by electric tractors. Owing to the extreme depth of these turntable pits and the shallow grade of the sewer in the vicinity it was necessary to provide against the sewage backing up into these pits by constructing a deep sump pit, into which both pits drain. Automatic ejectors discharge this drainage into the nearest sewer at a higher level.

COALING STATION—The main building of the coaling station spans eight tracks and serves an additional track at each end. It is 168x34 ft. in plan by 55 ft. high, and of reinforced concrete throughout. The bunkers rest on I-beam girders incased in concrete; the hopper bottoms are built of reinforced concrete and hollow tile.

There are three longitudinal bunkers, with a capacity respectively of 430 tons of bituminous, 813 tons of broken (anthracite) and 430 tons of buckwheat coal. These bunkers are divided into four compartments by transverse concrete partitions. Each track is served by three coal chutes, so that a locomotive on any one of the ten tracks may be coaled with either bituminous, broken or buckwheat coal.

The conveying machinery is divided into two separate and distinct units, each with a capacity of 100 tons per hour. The entire machinery is electric driven. Guards are placed over all exposed gears as protection to the attendants; and there are eleven emergency stations from which the entire machinery can be shut down by pressing a button.

West of the coaling station are the coal-storage tracks, with a capacity of forty cars. Provision is here made for thawing out frozen coal in the cars on these tracks, by means of live steam.

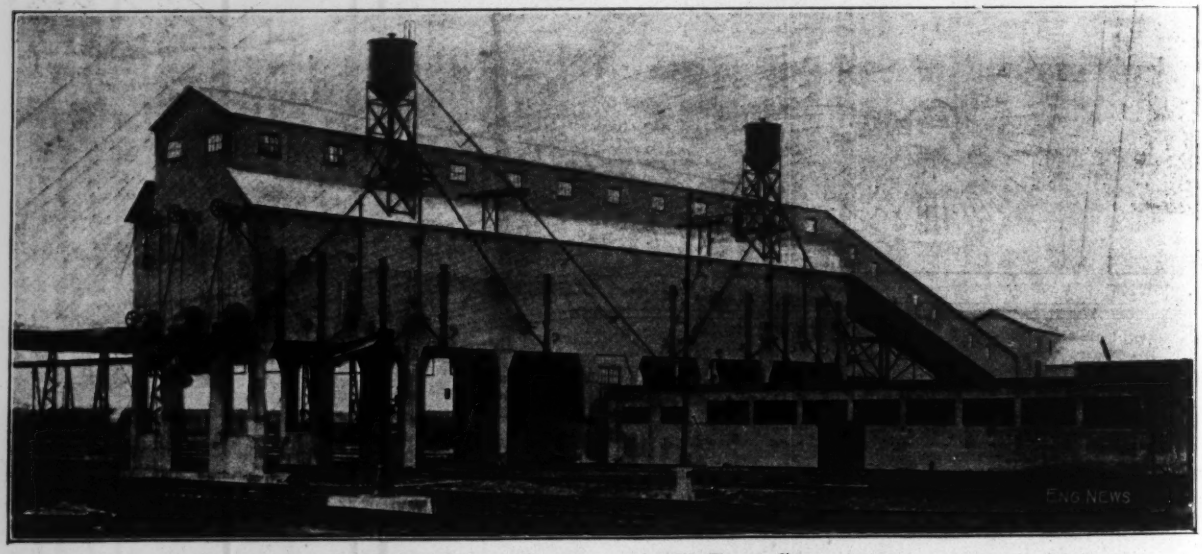


FIG. 3. COALING STATION OF 1700-TONS CAPACITY
(Contains three longitudinal bunkers for different classes of coal; each track is served by three chutes, one from each bunker. Sand tanks serving 10 tracks shown at top of building.)

SAND HOUSE AND CINDER PITS—Sand is dried and stored in a building west of the coaling plant. It is of reinforced concrete, 103x16 ft. and 40 ft. high. After the sand is dried, it is screened and elevated by means of compressed air to two storage tanks of 15-cu.yd. capacity

...cated on top of the coaling station. These tanks ... sand to the locomotives through cast-iron delivery ... and 10 wrought-iron telescope spouts serve the ten ...

...cinder pits, which are of the submerged type, are ... about 60 ft. east of the coaling plant; each is ... ft. by 12 ft. deep, and of reinforced concrete. ... pit serves two tracks which are 26 ft. c. to c. The ...ders are removed from the pits by electric traveling ...anes, operating a 1⅝-cu.yd. clam-shell bucket. Aside ...om the economy and speed of handling engines over these pits, this arrangement permits of the coaling of engines from cars by means of the clam-shell bucket, should occasion arise.

A tunnel is provided from the power house to the roundhouse for carrying all steam, air and water piping, and also all wires and cables for lighting parts of the building. This tunnel is of heavy reinforced-concrete construction, waterproofed, 6 ft. wide, 10 ft. high, and 367 ft. long, with a branch running to the 90-ft. roundhouse. The tunnel is well lighted. The power cables to the station terminal are carried in a tile and concrete underground duct line located in a paved driveway just north of the new coach yards and station.

The locomotive terminal was built by Westinghouse, Church, Kerr & Co., and designed by them in coöperation with the Central Railroad engineers.

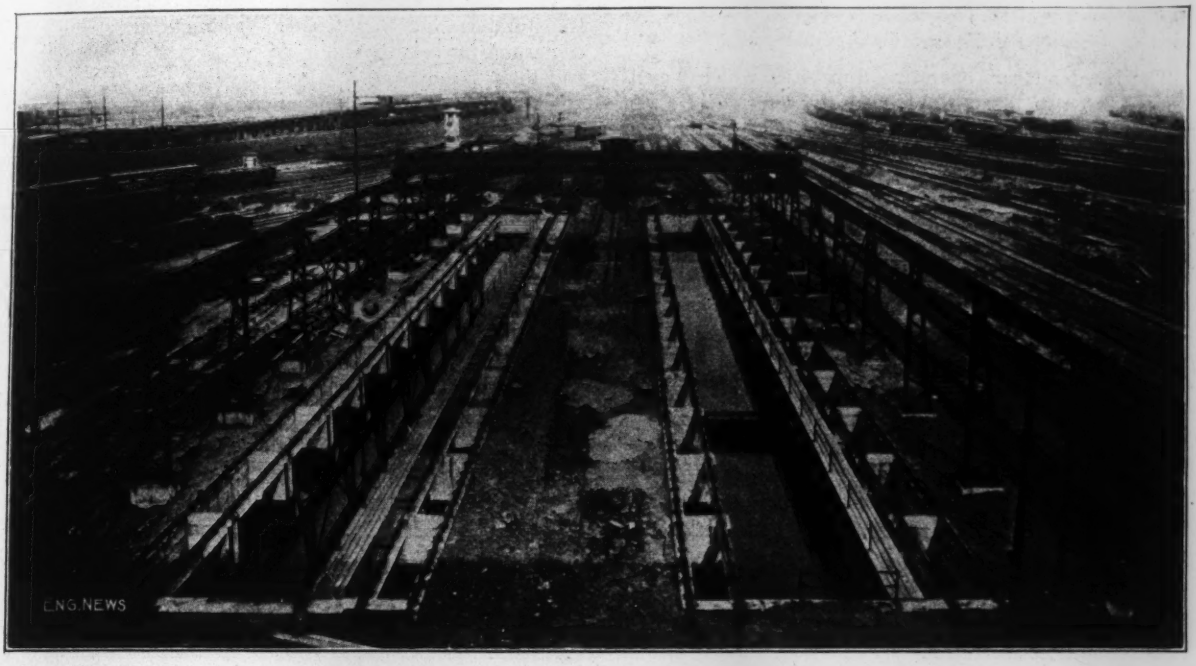


FIG. 4. THE CINDER PITS

(Ashes are removed from the pit by a 1⅝-cu.yd. clam-shell bucket on the crane shown. This same crane and bucket can be used for coaling purposes should occasion arise.)

INTERLOCKING SYSTEM

While not a part of the locomotive terminal, the interlocking system which governs all movements into the new trainshed described in last week's issue, and all movements in and out the locomotive terminal proper will be described here. The first interlocking plant related to this whole reconstruction work to be placed in service, was the one at the Van Nostrand place, about 3 mi. west of the North River. Next, on Mar. 12, 1911, the interlocking plant at Communipaw was put in service. The latter plant, located just west of the Communipaw station, governs the movement of trains across the New York-Newark Branch into the freight yards south of the station, and on down to the water front; also the movement of freight and coal from the south side of the main-line track to the west end of the main freight yard, across the main line to the main Jersey City freight station on Jersey Ave., and to large coal pockets located north of the passenger-terminal yard. This plant also governs movements in and out of the new locomotive terminal.

The movement of trains into the trainshed is governed by two plants; No. 1, the larger, controlling the shed tracks, while No. 2 governs engines into the locomotive terminal. One 179-lever tower, located south of the main track, about 800 ft. west of the new trainshed, is being built, which will replace both of the older towers. Each track in the new trainshed will be provided with at least two means for entry or exit, reducing the chance of blockades as the towerman will have the choice of several routes.

The interlocking plants were installed by the Union Switch & Signal Co., Swissvale, Penn.

PASSENGER-COACH YARD

The new passenger-coach yard will cover the ground once occupied by the old coach yard, engine terminal, coaling plant, and repair shop, which are now situated west of the trainshed and at the new Communipaw engine terminal.

The new coach yard and interlocking system controlling the new trainshed tracks will contain about 35 mi. of trackage, of which 25 mi. is new construction, and

6 mi. old tracks relocated. All trackwork was installed by the railroad and maintenance-of-way department.

CENTRAL RAILROAD CO. ORGANIZATION

The construction work was accomplished under the supervision of the Engineering Department of the Central R.R. of New Jersey: J. O. Osgood, Chief Engineer; A. E. Owen, Principal Assistant Engineer; J. J. Yates, Bridge Engineer; A. M. Zabriskie and H. E. van Ness, Assistant Engineers of Design; and C. M. Titsworth, Assistant Engineer in Charge of Construction.

Difficulties in Initial Operation of a 110,000-Volt Transmission Line

BY FRANK G. ALLEN*

The freedom from operating difficulties which may be secured, even in the initial period of operation of a very high voltage electric transmission line, where proper attention has been paid to every detail of design and construction is illustrated by the experience of the Georgia Ry. & Power Co., with its Tallulah Falls line.

This system was first put into operation Sept. 29, 1913, and regular service began Oct. 13. As already noted (ENGINEERING NEWS, Jan. 29 and Apr. 16, 1914) the Tallulah system comprises the power house, transmission line, five substations and a terminal station in Atlanta. Power is generated at 6600 volts, stepped up to 110,000 volts and distributed over steel tower lines of about 225 miles in length. The ultimate capacity of the development will be 60,000 kw., the present installed capacity being 50,000.

Voltage was first impressed on the section between Tallulah Falls and Atlanta with all apparatus connected thereto, and regular operation sustained to Dec. 25, without the slightest interruption from defective apparatus. At this time an insulator failed on an air-break switch at Gainesville, Ga., a station midway between the power plant and the Atlanta terminal station. This caused an interruption to the service of 15 minutes' duration. The same trouble was experienced with the same insulator again on Feb. 10. On Mar. 14, the first insulator on the 110,000-volt tower line gave way—on the branch section between Atlanta and Newnan. This was the first line trouble encountered after the operation was begun and in fact has been the only trouble to date. There was no loss of insulators or equipment when voltage was first put on the lines, and the interruptions mentioned above are the only ones which have been encountered due to defective equipment. This is very remarkable, considering the large number of substations and switching stations which are connected to the lines where insulation trouble is so liable to occur. There has been no loss of transformers, or any electrical equipment of any character except a few small instruments such as current transformers and high-tension bushings; these did not cause any interruptions but simply showed weakness and had to be removed.

There has also been unusual success in the operation of both high-tension and low-tension electrolytic lightning arresters. These arresters have been charged repeatedly since operation was begun without the slightest noticeable disturbance to lines or apparatus, nor have the disturbances been reflected to any indicating instrument.

EXTERIOR AND INTERIOR OF TELEPHONE STATION; TRANSMISSION TOWER, SHOWING MAIN-LINE CABLES (ABOVE) AND TELEPHONE WIRES (BELOW)

The engineering design shows many points of individuality and no money was spared to secure permanent safety of mechanical details. Aside from points discussed in earlier articles, the following are of interest.

The generators were among the first water-power machines to have spiders of rolled-steel plate to avoid possible unseen defects in steel castings—an important factor in protection against mechanical failure of a high-speed rotating element. This is especially important when it is remembered that all waterwheels are liable to attain runaway speed, and in some instances actually have with disastrous results. Furthermore, the rotors in the machines are designed to hold a runaway speed of 1.7 times normal for one hour (normal kinetic energy about 1,250,000 ft.-lb.).

Again, in anticipation of unavoidable serious variations in electrical operation, the generators are designed for an excitation of not more than 250 volts, normal ex-

*Secretary to C. O. Lenz, Consulting Engineer, 71 Broadway, New York City.

voltage, at 10,000-kw. load, 80% power factor and ...ator voltage of 7260 (normal voltage being 6600). ... design for adverse conditions makes possible an ab...te control of generator voltage, even under the worst ...ible line conditions, giving sufficient leeway to vary ... voltage through a wide range of power factor without ...r exciting the generator fields. This has been found ... further value since the generators operate at normal ...ting with almost no temperature rise, making it feas...le to increase the normal rating of the machines if such ...should be necessary under average operating conditions.

The high-tension wiring of the switch house is of copper tubing with bends made to fit designed forms and supported so as to give symmetry and the appearance (as well as the fact) of mechanical permanency to the entire layout. Where the high-tension wiring leaves the switch house, instead of the usual wall bushings (with a weather housing apparently intended to apologize for their inefficiency) oil-filled 150,000-volt wall bushings of special design are used, requiring no outside covering; when designed these were an advanced and original construction but one now coming into broader use.

The steel towers bore two ground wires and were considerably heavier than any heretofore installed in the South—the idea being that the cost of some extra metal is much cheaper than one failure and the consequent effect on the service. In the design of these towers particular attention was given to the condition of the heavy sleet which they would be called upon to withstand in this territory (a historical fact).

The substation in Atlanta in addition to being the largest outdoor type in the world, embodies features equally original. Special attention has been given as far as possible to eliminating high-frequency disturbances at the station, and this has been effected by unique but simple arrangements. The lightning arresters are tapped off at the end of the incoming lines as usual—but the horn gaps and arrester tanks are placed so as to furnish a straight path from the line to the tanks, enabling the latter to receive the dynamic blow of any oscillatory discharges while the power lines are turned through two right angles and a choke coil before entering the substation.

It might be interesting also to note that many of the high-voltage lines previously put into operation have been operated at a voltage considerably lower than that for which the lines were designed; for instance, lines designed for 110,000 volts have usually been operated at but 88,000 and for 140,000 volts have been operated at 120,000. This system herein referred to was designed for 110,000 volts and is actually operated at from 114,000 to 118,000.

The chief difficulty which has so far been experienced in the operation of this system has been one which has occasioned difficulty on all systems of high-tension lines. That is with the telephone line. This is of No. 4 copper-clad steel wire, strung on the steel towers some distance beneath the power wires. The telephone booths consist of portable sectional station houses—painted dark green and stationed within the square steel towers.

The telephone wire was originally supported on pin-type insulators—but it was found it could not thus be kept insulated from ground as the insulators punctured almost as rapidly as they could be replaced—and the service was extremely unsatisfactory. After several schemes failed, the entire line was restrung on high-voltage insulators. This was done between Tallulah Falls and Atlanta (about 90 miles), using suspension-type insulators with a special "S" hook. Now the talking is excellent and uninterrupted. Exhaustive tests and numerous oscilligraph records have shown the actual induced effects on the telephone line due to the power lines above. These data could not be secured with the line as first constructed because of the poor insulation, and have probably never before been secured with a similar transmission system; they should greatly influence the future design of such systems. The potential to ground induced on the telephone lines is between five and six thousand volts, and checks very closely with the theoretical. This potential, however, can be lowered somewhat by the use of a special drainage coil of heavy current capacity; there is also other protective equipment, like horn arresters, disconnecting switches, insulated platforms, etc.

In many cases it has been necessary to do switching with both low- and high-tension oil switches, but no damage has resulted to any equipment, and no surges of any consequence have been set up on the line as a result.

One incident of interest occurred at the power house. Lightning struck one of the feeders running to the Southern Power Co.'s system near the power-house building. The surge entered the building through the high-tension wall bushing, followed the high-tension wiring through the oil switch and was reflected by the transformers back to a post-type insulator which flashed through the brickwork to the steel column inclosed therein, a distance of some four feet and then went to ground. The only serious result was the loss of the copper tubing connecting the terminals of the transformer. This disturbance occurred, however, before the installation of the electrolytic arresters on this feeder, and the feeder was not protected by any other similar apparatus.

A similar incident occurred on June 4, when the entire district was visited by a severe lightning storm. The Tallulah system remained in operation, while several of the adjoining systems were repeatedly knocked out, the only effect felt on the Tallulah lines being a momentary drop in voltage of approximately 40%. This caused a few railway rotary converters in Atlanta to drop out of service for a few minutes, and occurred twice.

Charles O. Lenz, 71 Broadway, New York, was the chief engineer for the entire development from preliminary report to completion. C. E. Bennett has been the Assistant Electrical Enginer in charge of construction.

The Increasing Weight of Railway Rolling Stock—In 1829 a locomotive with two axles coupled, running on rails weighing 34.2 lb. per yd. weighed 5 tons, which was equal to 300 times the weight of rails per meter.

In 1846 an engine with three axles coupled, weighing 22 tons, ran on rails weighing 84.6 lb. per yd. This came to 630 times the weight of rails per meter.

In 1880 an engine with four axles coupled, weighing 56 tons, ran on rails weighing 84.6 lb. yer yd. This came to 1330 times the weight of rails per meter.

In 1911 a six-axle-coupled Golsdorf engine, weight 96 tons, on rails weighing 96.77 lb. per yd., gave a ratio of 2000. In 1911 also, in the United States, a "Mallet" engine with ten axles coupled, weighing 245 tons (adhesive weight), represented a ratio of 4600 times the weight of rails of 111 lb. per yd.; but this ratio, which is very high, is due to some extent to an exceptional weight per axle.

If adhesive force be taken as one-sixth of the weight, it will be found that the ratio of the tractive force at wheel tread to the weight of rails per meter has varied according to the values: 50—105—225—333—750.—Anatole Mallet before the Paris meeting of the Institution of Mechanical Engineers.

Recent Railway Construction in Chile

By Charles P. King*

SYNOPSIS—The Chilean Longitudinal Ry. is a part of the projected Pan-American Intercontinental Ry. Only a short section of about 93 miles of the Longitudinal Ry. remains to be built. This article describes in detail the general features of the line from Tacna to Port Montt, 2200 miles long, mentioning and describing connecting railways to the coast, and all the other principal railways in Chile, projected, under construction and completed. The effect of recent railway construction on the development of the mining industry is outlined. Much information is given about the needs and expected expansion of various industries for the benefit of engineering, contracting and equipment companies.

With the joining of the rails of the northern and southern sections of the so called Chilian Longitudinal Ry. at Yerbas Buenas, about 70 miles north of the port of Coquimbo, on Nov. 23, 1913, Chile has almost completed its part of the proposed Pan American Intercontinental Ry. Only a short section of about 93 miles, which will connect Arica in the north with the Nitrate Ry. at Jaz Pampa, now remains to be built in order to give to Chile a great trunk line over 2200 miles long, running due north and south from Tacna in the extreme north to Port Montt at the end of the habitable part of Chile in the south.

By far the greater part of this system has been built by the Chilian Government and is under Government control; and about 1000 miles of this has been built within the past three years. Unfortunately, a uniform gage does not exist, due to the fact that some of the connecting links of the system were built some years ago; but by far the greater part of the system between Arica and Santiago, the capital, is meter gage. Between Santiago and Port Montt it is all 5-ft. 6-in. gage. Between Tacna and Arica, in the extreme north, an English company has been operating about 47 miles of 4-ft. 8½-in. gage railway for many years past. This road forms the first link of the Chilian portion of the Pan American Ry.

Projected Arica to Jaz Pampa Section—Between Arica and Jaz Pampa, a distance of 93 miles, the government will soon build a meter-gage railway. From Jaz Pampa, about 28 miles inland from the nitrate or saltpeter shipping port of Pisagua, the Pan American Ry. is continued a distance of about 125 miles to Pintados, over the line of the Nitrate Railway Co., Ltd., another English company operating a standard-gage line (now being changed to meter-gage) between the ports of Pisagua and Iquique, serving the many nitrate works back of the coast in this section.

Pintados and Pueblo Hundido Section—The next link south, the first or northern section of the recently completed Longitudinal Ry., between Pintados and Pueblo Hundido, an inland station on the Chanaral Ry. (another English company), a distance of about 415 miles of meter-gage road, was recently turned over to the government by the contractors, MacDonald, Gibbs & MacDougall. The concession for the construction and operation of this road was first signed by the government on Apr. 23, 1910, with the Chilian Longitudinal Railway Construction Co., Ltd., and the Chilian Railway Finance Co., Ltd., which later transferred their rights to the Chilean Northern Railway Co., Ltd.

This latter company entered into a contract for the construction of the line with the Chilean Construction Co., Ltd., which in turn sublet the contract for the carrying out of the work to MacDonald, Gibbs & MacDougall. All of these companies are English, but an American, Judge Coyne, of Tennessee, was largely instrumental in securing the concession and in forming the company that will operate the road for a period of 25 years. The contract price for the construction of the road was $15,275,000. Most of the locomotives required for construction work and afterward turned over to the operating company were purchased in Germany. The reason for the purchase of most of this equipment from the Germans, as given to the writer by one of the contracting company, was that quick delivery could not be obtained from American builders and the lowest price obtainable from English builders was $1425 per locomotive (for Mogul) higher than the German price.

It was further stated, however, that these German engines have not proved first-class, and that the most of them will have to be scrapped soon. It might, therefore, be well for builders of motive-power equipment and rolling stock to keep in touch with the Chilian Northern Ry. Co., Ltd., the operators of the road, addressing them either at their London offices at 3 Princes St., E. C., or at Santiago, Chile, Calle Agostinas 718.

The railway from Pintados to Pueblo Hundido for the most part was of easy construction, traversing desert country and crossing the enormous nitrate deposits back of the ports of Taltal, Aguas Blancas, Antofagasta and Tocopilla, a route which allowed the permanent works to be of a comparatively simple nature. There are no tunnels and only one bridge in its entire length and the maximum gradient is 3%. The sharpest curve has a 100-m. radius. The rails are 50 lb. per yd. and the sleepers are native wood.

From this northern section the railway is continued over a section of meter-gage railway built by the Public Works Department of the government, a distance of about 100 miles to Copiapo.

Copiapo and Cabildo Section—From Copiapo south to Cabildo, a station on the Calera branch of the State Railways, about 140 miles from Santiago, the road was built (the rails were joined on Nov. 23 last, as mentioned above) by a French company, the Regie General du Chemin du Fer au Chile, having offices both in Paris and Santiago. The contract for the construction and operation of this road for a period of 30 years was signed by the government with the Howard Syndicate, Ltd. (another English concern), which in turn made a contract with Griffith & Co. for the construction work. In March, 1911, due to financial difficulties, both the Howard Syn-

*50 Church St., New York City.

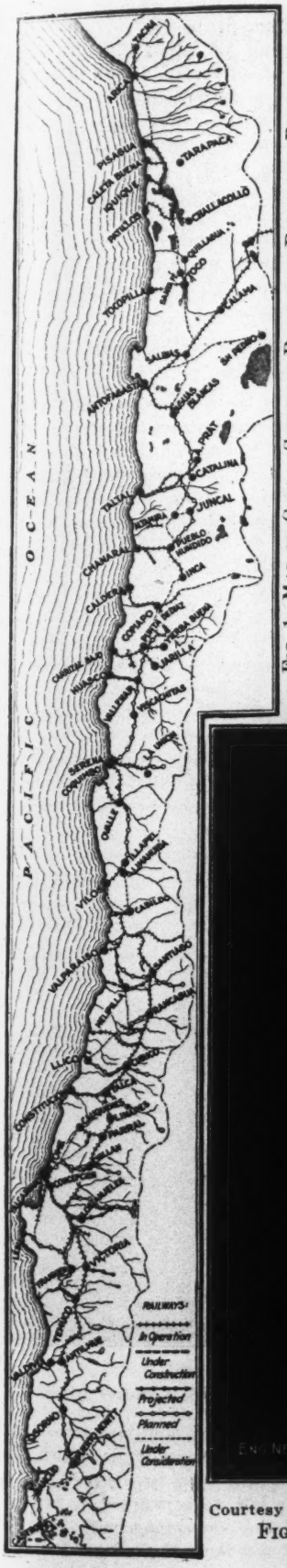


FIG. 1. MAP OF CHILE, SHOWING PROJECTED RAILWAYS, RAILWAYS UNDER CONSTRUCTION AND EXISTING LINES

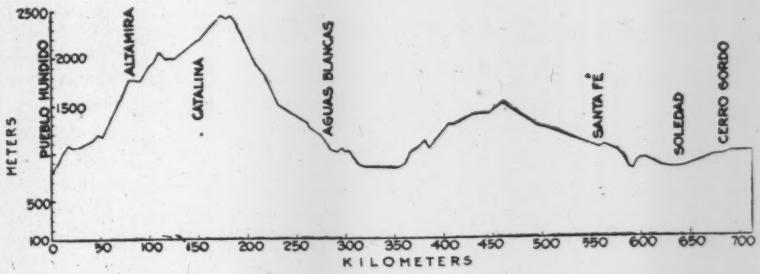


FIG. 2. PROFILE OF THE CHILEAN LONGITUDINAL RY. FROM PINTADOS, THE JUNCTION EAST OF IQUIQUE, TO PUEBLO HUNDIDO, THE JUNCTION EAST OF CHANARAL

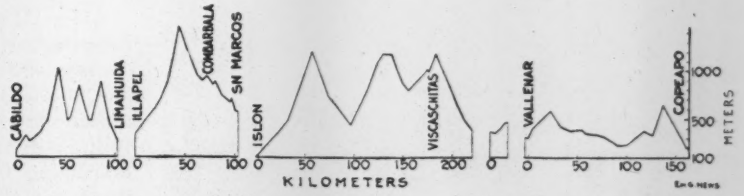
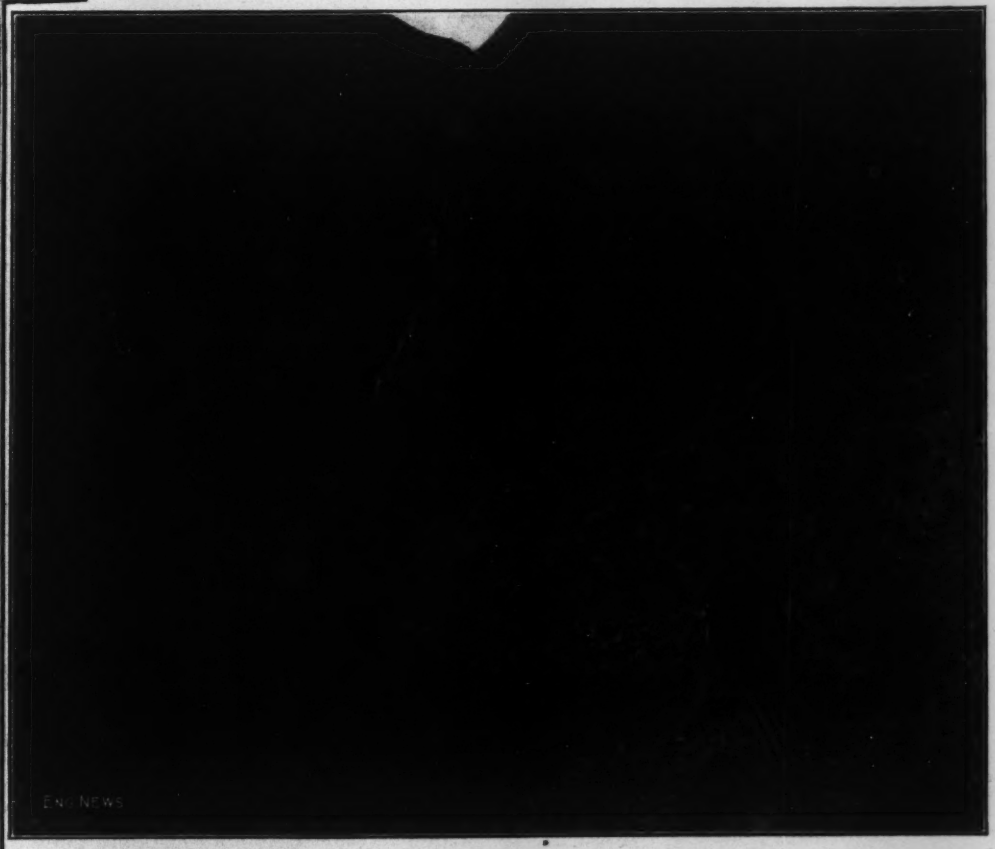


FIG. 3. PROFILE OF THE CHILEAN LONGITUDINAL RY. FROM COPIAPO, THE JUNCTION EAST OF CALDERA, TO CABILDO, THE SOUTHERN TERMINUS, NORTH OF SANTIAGO

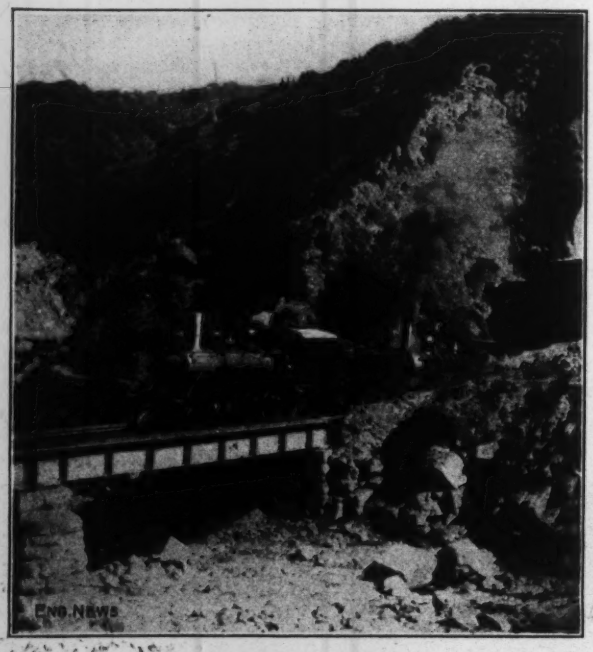


Courtesy Bulletin Pan-American Republics

FIG. 4. TUNNEL THROUGH THE ANDES MOUNTAINS ON THE TRANS-ANDEAN RY. FROM VALPARAISO TO BUENOS AIRES

dicate and Griffith & Co. gave over control of the road to the French company.

This section is about 310 miles in length, meter gage, and the contract price for its construction was $20,130,000. The road was a most difficult one to build, presenting many engineering problems. There are many tunnels, the longest being the Espino tunnel, 4790 ft., bored through solid rock and at an elevation of 4800 ft. above sea level. There are also three other good sized tunnels just north of Cabildo, one of 4150 ft., one of 3360 ft., and one of 2565 ft., besides a number of smaller ones,



Courtesy Bulletin Pan-American Republics

FIG. 5. BRIDGE ON THE CABILDO R.R. BRANCH OF STATE RYS.

making construction expensive, on which the contractors are stated to have lost considerable money.

At the station of Limahuida, about 75 miles north of Cabildo, a section about 12 miles in length built by the Public Works Department to connect the interior town of Illapel with the port of Los Vilos, is used to connect Limahuida with Illapel. Between San Marcos and Islon (near the port of Coquimbo) another section of 130 miles built by the Public Works Department is utilized. As about 72 miles of this (between Ovalle and Islon) is 5-ft. 6-in. gage, a third rail has been laid to meter gage. Just north of Cabildo at the station of Palquico, the road is built as cremallera, or rack, for a distance of 36 miles, although the grades are but from 3% to 6%. Just north of Illapel, the rack system is again made use of for a distance of about 10 miles over a section of almost steady 6% grade which also passes through the Espino tunnel mentioned above. It is stated that this rack section cost $65,000 per mile to build.

Most of the rolling stock and motive-power equipment used in the construction of this section was also purchased in Germany and Belgium, although three 70-ton Shay-geared locomotives, built by the Lima Locomotive Corporation, of Lima, Ohio, were used in the construction of the heavy-grade rack sections.

The Regie General du Chemin du Fer au C[illegible] the builders, although now having difficulties with [illegible] government over the question of settlement, caused [illegible] their construction losses, will, it is fully believed, ca[illegible] their contract to operate the road for 30 years; [illegible] so, they will be obliged to purchase considerable [illegible] power equipment and rolling stock.

From Cabildo, the end of the southern section [illegible] the Longitudinal to the Capital, Santiago, the Pan Am[illegible] route follows the recently built branch of the Stat[illegible] Rys. to Calera, a distance of 72 miles, where it joins the [illegible] line of the State Rys. between Valparaiso and Santiago, all of which is 5-ft. 6-in. gage.

EFFECT OF RAILWAY DEVELOPMENT ON MINING AND INDUSTRIES

Already the opening up of the southern section of the Longitudinal has stimulated the mining industry in the district between Cabildo and Copiapo, and as both north and south sections traverse an extensive mineral zone containing copper, iron, silver, nitrate, borax, etc., it is fully believed that the road will be the means of largely developing these industries in a section that has been heretofore but little worked.

NITRATE WORKS—The Longitudinal Ry. is crossed at several points by private railways, mostly English, which serve the many nitrate works, carrying nitrate to the ports of Pisagua, Caleta Buena, Junin, Tocopilla, Mejillones, Antofagasta, Caleta Coloso, Taltal, and Chanaral. This nitrate industry is Chile's most important one. The export duty on the 2½ to 3 million tons of nitrate exported annually, mostly from the above ports, is about 60% of the revenue of the entire country, and the nitrate is about 70% of all the exports.

The present price of nitrate alongside vessel in the above ports is $1.90 per quintal (100 lb.), and the export duty on the same is $12.34 per metric ton. It is said there is sufficient nitrate in Chile to last another 75

Courtesy Bulletin Pan-American Republics

FIG. 6. VIEW OF NITRATE WORKS ON LONGITUDINAL RY.

years, and as the Longitudinal Ry. now taps important nitrate fields, it is expected that these lands, which are owned by the government, will soon be disposed of by public sale, as provided by law, to be worked by private parties. With the aid of the connections with English private lines, mentioned above, the Longitudinal Ry. and

the various intersecting government-owned railways will also be of great aid in the development of the important and growing copper and iron mining industry of the country.

Copper Mines—The American promoters, the Guggenheims, have for many years past been large buyers and shippers of copper ore from Chile to the States and for the past few years have worked a large mining property, including a smelter and 46 miles of railroad, in the south under the name of the Braden Copper Co.* The Braden Ry. is a heavy-grade road of but 2-ft. 6-in. gage connecting Rancagua on the main line of the Chilian State Rys. with the mines at Teniente and is operated by eight 42-ton Shay-geared locomotives.

Just recently the Guggenheims, under the name of the Chile Exploration Co., have purchased a very large copper property back of the small port of Mejillones, 12 miles north of Antofagasta and it is said they will invest an enormous sum of money in its development, among other things building a 40-mile meter-gage railway from Mejillones, and 11 miles of standard-gage railway about the plant.

A syndicate headed by William Braden, formerly President of the Braden Copper Co., before it was sold to the Guggenheims, has recently acquired large copper properties back of Chanaral, to which property they will, it is said, soon build a railroad and erect a smelter, etc.

There are also fair sized smelters at Gatico (near Antofagasta) and Guayacan (near Coquimbo), both operated by Chilian companies, and it is expected, due to the fact that shippers will now be able to get their ore to the coast at a much lower rate than formerly by making use of the Longitudinal Ry., that there will be a couple or more new smelters erected near Antofagasta.

Arica-La Paz Ry.—Large quantities of copper ore are now shipped regularly from the port of Arica, in the extreme north, but this ore is mostly from the Corocoro mines in Bolivia and comes into Arica over the recently finished Arica-La Paz Ry.*, which was opened to traffic in July last, having been built by the English contractors, Sir John Jackson & Son, after a Chilian company, the Sindicato de Obras Publicas, had failed. The locomotives in use are German—Esslingen, Borsig and Henschel—and the cars are all steel, both passenger and freight, from the Middletown Car Co., Middletown, Penn. At present there is but one through train a week over the road in either direction, and while the traffic is bound to increase it will be many years before it will be an important freight road or one that will pay. In fact, it was built mainly for political reasons.

Courtesy Bulletin of Pan-American Republics

Fig. 7. Railway Bridge over the River Lute, on the Antofogasta & Bolivia Ry.

Antofogasta & Bolivia Ry.—The Antofogasta & Bolivia Ry., a 2-ft. 6-in. gage railway running from Antofagasta to Oruro, Bolivia, a distance of 574 miles, crosses the Longitudinal or Pan American route at Baquedano, and is an important factor in the development of several small copper mines near Calama and the very important group at Collahuasi, on a short branch road at an elevation of 15,814 ft. above sea level. At San Pedro station (193 miles from Antofagasta and 10,700 ft. above sea level) are situated the collecting reservoirs, blasted out of solid rock, built by the railway company at an expense of about $5,000,000 to supply the town of Antofagasta, the nitrate works and its own service with water, for no other fresh water can be obtained except by condensing the sea water.

The main railway has to reach an altitude of 13,000 ft.

*Described in "Engineering News," May 22, 1913.

*Described in "Engineering News," Nov. 27, 1913.

in 223 miles. At 12,000 ft., mile 240, it runs alongside a wonderful lake of borax, 24 miles long, owned and worked by the Borax Consolidated Co., and said to be the largest single deposit of borax in the world, and the main source of the world's supply.

At about 205 miles from Antofagasta, the road crosses the river Loa on what is said to be the highest viaduct in the world and certainly one of the most interesting engineering structures in the world. The level of the rails on the viaduct is nearly 10,000 ft. above the sea and at a height of 336 ft. above the surface of the waters of the river below. The viaduct consists of six lattice-girder spans, of 80 ft. each in the clear, supported on steel trestle towers. At Huari, mile 497, there is the mysterious fresh water lake Poopo, which receives 212,000 cu.ft. of water per minute, and only 2000 cu.ft. flows out of it. There are also many other wonders of nature along this line, among them the snow-capped volcanoes of San Pedro and San Pablo, from the former of which there is a steady column of smoke constantly ascending, and the giant Ollague, over 20,000 ft. high.

There are many branch lines (some recently built) tapping the main road serving the nitrate works and copper mines adjacent; the principal ones are those to the Boquete nitrate fields, a distance of 70 miles, to the port of Mejillones, and to the Collahuasi copper mines, a distance of 60 miles. There is also a private railway from Uyuni, mile 378, to the famous Huanchaca silver mines, now being worked by an American company.

The principal branches of the Antofagasta & Bolivia Ry., however, are the recently completed ones from Rio Mulato (mile 443) to the old Bolivian city of Potosi and from Uyuni (mile 378) to Tupiza, near the Argentine border of Bolivia, a distance of 122 miles. The former railway, while but 108 miles in length, was by far the most difficult and expensive to build as it traverses [illegible] wind-swept and often snow-covered country alm[illegible] its entire length, winding around mountain after mo[illegible]ain and through deep cuttings through solid rock, a[illegible] at mile 51 from Rio Mulato the rails reach an elevat[illegible] of 15,814 ft. above the sea, making this the highes[illegible] rail-road in the world. Both of these roads were bu[illegible] by American contractors.

The Antofagasta & Bolivia Ry. has also recently [illegible] a meter-gage railway from Oruro, the end of their m[illegible] line in Bolivia, to Cochabamba, a distance of 124 [illegible].

About four years ago, this company acquired the co[illegible]trol of the road built by an American company f[illegible] Oruro to La Paz, a distance of 127 miles, which, [illegible] the branches mentioned above, gives a big and gro[illegible]

Courtesy Bulletin of Pan-American Republics

FIG. 8. PORT AND RAILWAY TERMINAL AT TALCAHUANO

traffic; with the result that it has been decided to widen the gage to meter and substitute 70-lb. rails for the old 65-lb. ones now in use.

For the increasing traffic and the change in gage, the company will soon be in the market for motive-power equipment, cars, rails, etc. While the company is English, with head office in London, offers by American manufacturers desirous of doing business with it will undoubtedly receive every consideration. It was reported some little time ago that the control of this road had been obtained by the Brazil Ry. interests (offices at 25 Broad St., New York), but the facts are that while the Farquhar interests did obtain about ten millions worth of stock of this road, they were forced to hypothecate it with English banks almost immediately; and the control of the company is still strictly English.

IRON MINES—The Bethlehem Steel Co. is also now building a short railroad from its recently acquired iron-ore deposits at Tofo, near Coquimbo, to a small port just north. It is stated that these deposits, acquired

from a French company, contain over 100 million tons of about 67% ore, mostly on the surface.

Railways South of Calera and Santiago

From Calera south, the Pan American route is continued over the main line of the Chilian State Rys. (5-ft. 6-in. gage) to Osorno, a distance of 665 miles. From Osorno to Port Montt, the end of the habitable part of Chile, a distance of 79 miles, the road was only recently finished and turned over to the government. It also is 5-ft. 6-in. gage.

From the port of Lebu, about 300 miles south of Valparaiso, a road of 101 miles in length, 5-ft. 6-in. gage, to Los Sauces, on the main line of the State Rys. is being built under government guarantee by an English company, the Chilian Eastern Central Ry. Co., Ltd.; but this company is now temporarily financially embarrassed and active construction work has been stopped. This road, when finished, will open up a rich mineral and farming section for development, and give a better outlet for the large quantities of good coal mined at and near Lebu.

On the island of Chiloe, just south of Port Montt, the Chilian Government has just finished the construction of a 62-mile, 75-cm. gage railway from Ancud to Castro.

Smaller Railways

Several shorter railways have also been built for the government during the past two years, such as the 17-mile meter-gage railway connecting the port of Papudo, north of Valparaiso, with Ligua on the Longitudinal Ry. A considerable mileage has been built by private companies, especially in the nitrate section, but enough has been written here to show conclusively that Chile has progressed rapidly with railroad building during the past few years, and while this rate of progress will not be kept up there are still quite a number of roads which the government have ordered surveyed and will very likely order to be built soon. Among the projects now pending is the proposed railway from Santiago to Valparaiso via Casablanca to avoid the heavy grades on the present line. They are also studying the question of electrification of the present road between these two cities, and there is some talk of this work being carried out instead of building the road via Casablanca, but due to the heavy initial cost of electrification and the present bad economic condition of Chile, this latter plan will probably fall through.

Trans-Andean Railways

While there is at present one trans-Andean railway connecting Valparaiso and Buenos Aires,* the Chilian and Argentine Governments contemplate the building of two other roads to connect these countries, one in the north from Caldera to Buenos Aires putting the arid nitrate section of Chile in touch with the rich agricultural section of the Argentine, and another line in the south from Valdivia to connect with the Argentine Great Southern Ry. at San Martin de los Andes, on the Chilian border.†

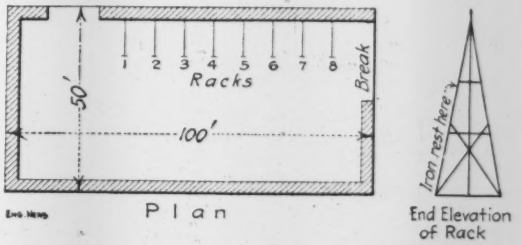
Either of these lines would reduce the climb over the present trans-Andean road about one-half, which would make them practical freight routes, while the present railway can only be used profitably for passenger and light freight and express service. The northern line will require a tunnel of only 1640 ft. to pierce the Andes at the point selected; while to build the present trans-Andean line a tunnel over a mile long at an elevation of almost 12,000 ft. was necessary.

The Chilian State Rys., not including the roads recently built and mentioned in this article, have about 600 locomotives and over 7000 cars in use and the government will buy in the near future 100 more locomotives and over 1000 cars.

*Described in "Engineering News," Jan. 4, 1912.

†Surveys for this railway described in "Engineering News," Feb. 12, 1914.

A Brick Wall Wrecked by an Interior Blow—A three-story brick wall of a large warehouse owned by the Huey & Philps Hardware Co., Dallas, Tex., was wrecked in a remarkable manner when a wood rack for holding iron bars, rods, slats, etc., failed under load. Tracks of the Texas & Pacific Ry. pass the building on the side which failed, and it is suggested that vibration caused by a heavy freight



(The racks were built of timber in the manner shown. The collapse of rack 1 with its load caused the other racks to fall successively, from impact.)

Fig. 1. Plan of 3rd Story, and End Elevation of Supporting Frame for Steel Rack, Etc.

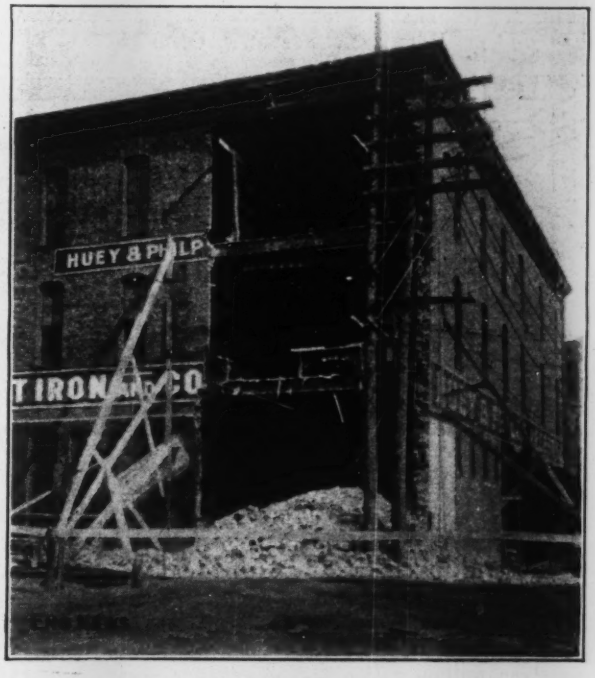


Fig. 2. Showing Break in Wall

train probably unbalanced the load on rack No. 1, which was the first to fail, so that it collapsed against No. 2, and so on successively, finally breaking down the wall. The manner of this accident is shown in Fig. 1, and the result in Fig. 2. The accident occurred during the night, July 10, and no one was injured.

Changes and Enlargements of the Water-Purification Plant, Youngstown, Ohio

Extensive changes of an interesting character are now being made in the water-purification plant of Youngstown, Ohio. The present settling reservoirs are to be replaced by much larger ones, and the old reservoirs are to be used for new mechanical filters above and for clear-water storage below. The existing mechanical filters are to be raised to a level suggested by the flood of 1913, and during the process their piping and gutter systems will

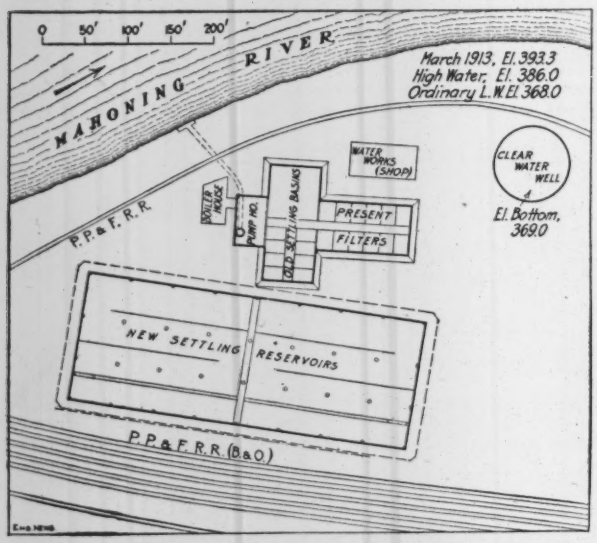


FIG. 1. GENERAL LAYOUT OF WATER PURIFICATION PLANT, YOUNGSTOWN, OHIO

57x135 ft., was far too small to give an adequate sedimentation period, and the filters, overloaded by normal duty, were further taxed by having to handle water insufficiently cleared in the settling basin. The new settling basins were laid out, close alongside the water plant, of aggregate dimensions 150x400 ft., about eight times the area and three times the length of flow available in the old basin. The new basins (Fig. 2) are wholly of reinforced-concrete construction, with buttressed outer walls and continuous slab floor. The basins are 19 ft. deep.

When the new basins were projected, the elevations of the old basin and filters were adopted for the new work. The flood of March, 1913, however, 8 ft. above any previous record, rose some 2½ ft. over the filter-house floor, and it was then decided to raise the new work 3½ ft. for safety against future great floods. Part of the excavation for the first of the new settling basins had already been carried down to the footing-level first intended, and this was refilled to the new elevation. This basin is completed and in operation, and concrete work on the walls and floor of the second basin is in active progress.

The old basin, 20½ ft. deep, gives a depth of 24 ft. up to the new level of top, for filter and clear-water-basin construction. A reinforced-concrete slab and beam floor, on columns 16 ft. on centers longitudinally, is to be built 9½ ft. below the new top of the side walls (Fig. 3). Below this a clear height of 11½ ft. will be available for clear-water storage. The floor will carry the 16 new filters, 14 ft. 8 in. by 22 ft. 3 in. inside, 8½ ft. deep, separated by a central longitudinal distribution gallery 10 ft. wide in the clear.

Removal of the baffle walls in the old basin is now going on, to be followed by construction of the new bottom slab and lining, intermediate floor and filters. When these

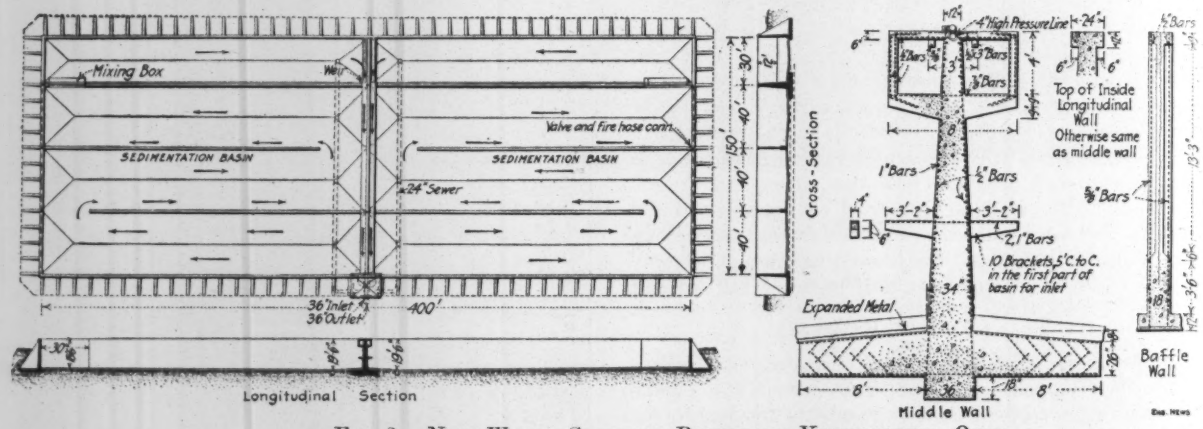


FIG. 2. NEW WATER SETTLING RESERVOIR, YOUNGSTOWN, OHIO

be rearranged. The flow of the Mahoning River is to be equalized by the construction of a large dam, and a new pumping station is being built, adjoining the filters.

Increase of capacity is demanded by the growth of the city. The daily pumpage is increasing each year by nearly a million gallons. The existing plant (Fig. 1), comprising twelve 850,000 gal. units, is overtaxed by the present requirements of the city. To meet future needs, a set of 16 additional units of the same size is being built.

The principal element of trouble in the raw water is high iron content and general turbidity. The old basin,

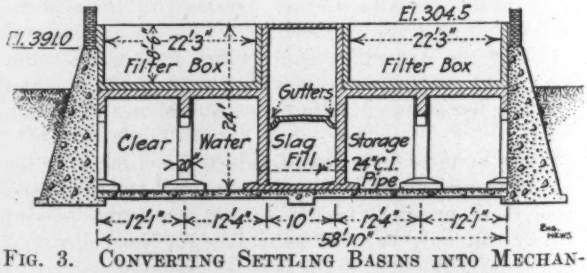


FIG. 3. CONVERTING SETTLING BASINS INTO MECHANICAL FILTERS AND CLEAR-WATER BASIN, YOUNGSTOWN, OHIO

completed, the old filters are to be put out of service and rebuilt to a level 3½ ft. higher, and with new water and collecting systems, all as shown by Fig. 4.

Removal of the pumping station from the east bank to location alongside the filter plant is being prepared for

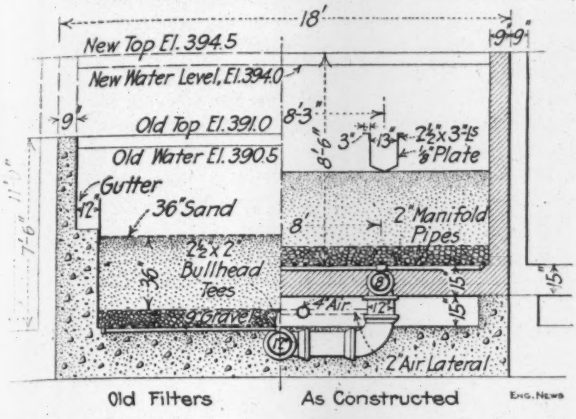


FIG. 4. RECONSTRUCTING A MECHANICAL FILTER AT YOUNGSTOWN, OHIO

by foundation work at the new site. A contract was let recently for the chimney of the new station, a reinforced concrete stack 10x200 ft. (238 ft. high above foundation). Soft clay and a thin stratum of quicksand underlaid by hard gravel form the subsoil of the site. The foundations will be carried down to the gravel, some 20 ft. below original ground surface.

The contract for the filter-plant construction is being carried out by W. H. Henderson, of Youngstown. Heller Bros. are contractors for the pumping station. The Weber Chimney Construction Co. will build the new stack. Contracts for the pumping machinery have not yet been let.

The present filter equipment is said to be producing a highly satisfactory effluent. Treatment with hypochlorite has not been used at Youngstown, and is not contemplated. In April, the tests of the filtered water are reported as showing only two 10-c.c. samples with B. Coli, no coli found in 1-c.c. samples. The interval between washings averages 24 hr. with the new settling basin in operation, whereas before that period the worst conditions called for washing every 4 hr.

F. M. Lillie is City Engineer of Youngstown, and J. S. Lewis is Superintendent of Water.

A Large Open-Air Swimming and Wading Pool

An open-air public swimming and wading pool has been built in the Fair-Ground Park at St. Louis, Mo., which is said to be the largest ever built. The pool is approximately circular, but is divided into two unequal parts by a wide promenade, as shown in Fig. 1. The pools, sand beach and dressing rooms occupy about five acres.

The larger portion is the swimming pool, 440x270 ft., with a maximum depth of 10 ft. at the driving platform; its area is 99,724 sq.ft. and it holds 751,000 gal. of water. It has a 4-in. and a 6-in. supply main under 30-lb. pressure, and a 15-in. and 16-in. drain; it can be filled in 44 hr. and emptied in 20 hr. The smaller portion is the wading pool, 345x120 ft., with a maximum depth of 42 in. It has an area of 31,520 ft. and contains 361,500 gal. of water. It is supplied by a 6-in. main under 30-lb. pressure, and has a 12-in. drain, so that it can be filled in 5½ hr. and drained in 2 hr. The bottom is of reinforced-concrete slabs 2½ in. thick, laid on a bed of well-rammed cinders, and having expansion joints spaced 8x20 ft. These joints are constructed as shown in Fig. 2. The diving platform also is of reinforced concrete.

The dressing-room building contains 236 dressing rooms, besides children's rooms, locker rooms, toilets, shower baths, etc. It is so arranged that bathers going to the pool walk through a shower bath, while those coming from the pool walk through a shallow concrete foot

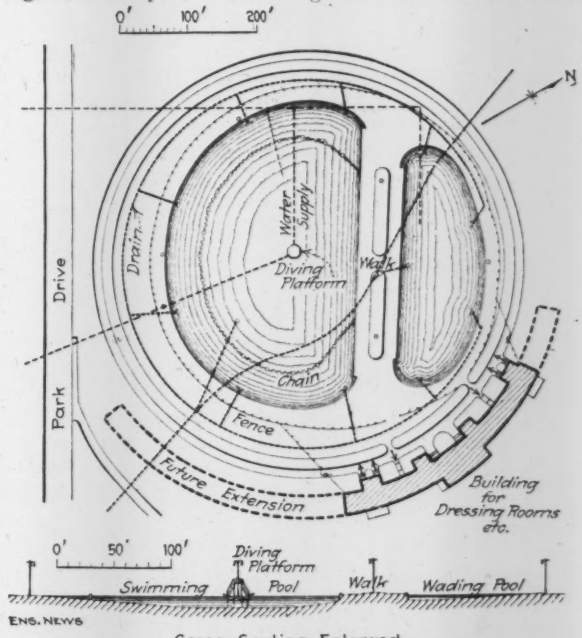


FIG. 1. PLAN OF SWIMMING AND WADING POOL IN THE FAIR-GROUND PARK, ST. LOUIS, MO.

bath, to prevent tracking sand and dirt into the rooms. On the opening day the pools were used by 10,000 persons.

The pools and building were designed by Geo. E. Kessler & Co., landscape architects, St. Louis, and were built under the direction of Nelson Cunliff, Superintendent of Construction of the Park Department. All work on the pools was done by the park employees, and the contract

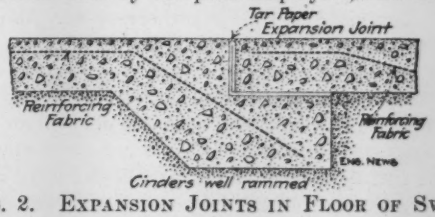


FIG. 2. EXPANSION JOINTS IN FLOOR OF SWIMMING POOL

for the building was let to Godfrey & Hirsch, of St. Louis. The approximate cost was as follows: grading and shaping, $13,000; concrete, $9000; sand beach, $1000; building, $16,000; total, $39,000. The extension of the building will cost about $21,000, making a finished total of $60,000.

The Results of City Planning in Essen, Germany

By Harold M. Lewis*

The city of Essen, Germany, best known as the home of the Krupp Steel Works, and the center of the largest coal-mining and industrial district of Germany, has, in the last few years, come to be recognized as one of the leading cities in yet another development—that of modern city planning. It is especially interesting in this respect, as it is still under the impetus of a rapid growth, which first made apparent the need for a large and comprehensive street plan, and the growth of this new plan and the contrast between old and new methods can be readily observed at this time.

The population of Essen, on Mar. 1, 1914, was 323,259, an increase of 172% over the figures for 1900, which were 118,862. During this period several outlying districts were joined to the city and, further, such additions now under consideration will bring the total to nearly 500,000. In the year 1910, of the wage earners in the city, 92.15% were receiving annual incomes of only 216 to 720 dollars, and therefore the housing plans of Essen must provide for an enormous number of cheap homes. The problem of combining cheapness, attractiveness and healthfulness, however, is being successfully solved. The bettered conditions in the last respect is shown by the fact that in the years 1900 to 1910 the death rate of Essen was decreased from 25.84 to 12.35 per 1000.

Essen is situated on a high plateau, the largest part of which slopes northward to the Emscher River and a smaller section of which drops off suddenly toward the Ruhr River on the south and east sides. The problem of fixing upon a comprehensive and adequate street plan was complicated by several factors. First of all by the topography of the land, which is decidedly rolling and at the outskirts of the city is sharply cut by valleys running in various directions and which must be bridged over in order to afford a satisfactory prolongation of the main traffic streets. A second important factor is the presence of the Krupp Steel Works in the very center of the city and occupying a large site which is cut by comparatively few streets. There are also about fifteen coal-mine shafts scattered over the city and the plants connected with these and their monstrous piles of stone wastes form yet another impediment to a complete street plan. Moreover, the city is covered by a network of railroads to furnish transportation facilities for the products of the Krupp Works and the various coal mines, and in many places infrequent crossings under these railways (they are practically all on embankments) cause long detours.

An examination of a map of Essen shows a very complete system of radiating streets leading toward the center of the city, but as these approach the old section they become almost hopelessly lost, as there are no adequately wide streets cutting across the old part of the city. There are, however, a couple of such streets already planned to relieve the existing conditions. This old section might be described as a series of squares and market places connected by narrow, winding and often hilly streets. It has been found necessary to place one track of the trolley line on Kettwigerstrasse on a back street, and the remaining track runs so close to the sidewalk that a pedestrian cannot safely walk too close to the curb. At the time of the daily closing of the Krupp Works this street presents a scene very similar to Nassau St., in New York City, at the noon hour.

A stranger passing from this section of the city to the new district south of the Central R.R. Station would at once notice a difference. The streets are much wider and many of them are attractively planted with trees and shrubbery. Public parks and lawns, which were noticeably absent in the old part of the city, are everywhere within easy reach. One similarity is apparent, and that is that the streets at first seem to be hopelessly tangled and crooked, but as soon as their arrangement is studied it becomes apparent that this is a carefully planned disorder.

The whole street system is worked out with the primary aim of a characterization of the streets, and there is probably no other city in which this fundamental German idea has been so completely developed. The aim of the planner was to furnish, throughout the city, constantly new and varied vistas, not only in respect to the houses and their relations to the streets, but also in the width and arrangement of the individual streets. The completeness with which this has been carried out is shown by the fact that the range of vision in the streets is, as a rule, limited to 650 to 1000 ft. The main traffic streets are often exceptions to this rule, but every opportunity has been taken to avoid monotonous stretches on these.

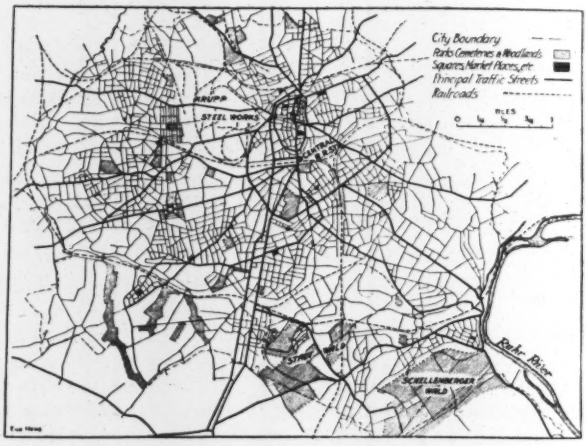
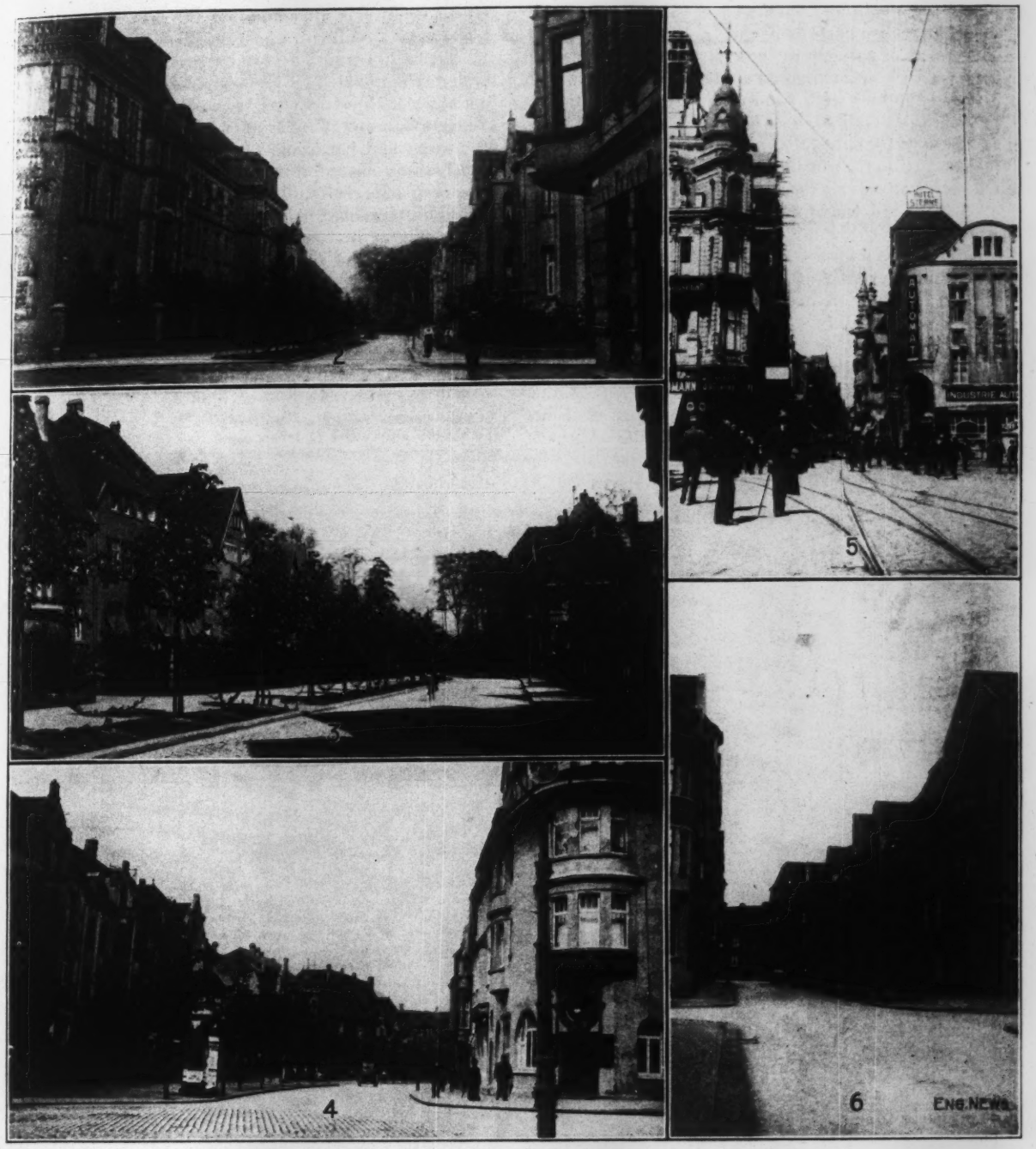


Fig. 1. Street Plan of Essen, Germany

To one used to the average American city plan, Essen streets are at first very confusing and the short and crooked streets perhaps lose some of their attractiveness when they become solidly built up to the sidewalk line with ordinary houses, and the lack of any long views may give a crowding and oppressive effect. A distinct advantage of the irregular system is the readiness with which large open places can be created at the main intersections by the cutting off of sharp corners, and advantage has been taken of this in Essen.

Not only do the streets differ from each other, but in many cases the individual streets are unsymmetrically arranged so as to avoid any chance of monotony. That is, the sidewalk is often a wide promenade on one side and an ordinary sidewalk on the other. Several very attractive streets are arranged with a single line of trees

*Engineer, Emscher River Board, Essen-Ruhr, Germany.



FIGS. 2-6. SOME STREETS IN THE CITY OF ESSEN

(1, Beethovenstrasse, showing very narrow paved roadway and planting strip on one side. 2, Richard Wagnerstrasse, showing festooned vines in planting strip. 4, Moltkestrasse, an attractive curved street. 5, Kettwigerstrasse, in the old section. 6, Irmgardenstrasse, a typical short street in the new section.)

which are placed along a wide and principal footway. Another attractive arrangement is made with three rows of trees by placing the main footway between two of them on one side. Even the stereotyped system with two rows of trees is varied by surrounding one by a grass plot and the other with mosaic-stone pavement. Richard Wagnerstrasse has on one side an attractively planted parkway about 35 ft. in width between the houses and the main sidewalk, as seen in Fig. 2.

It has been attempted to segregate the residences in small groups each of which shall have its own retail stores. An open market place is also usually provided for each residence section. This plan has been greatly aided by the Krupp Co., which has established throughout the city a series of colonies for its employees. The most interesting of these are Magarethenhöhe, a colony for the Krupp officials, and Altenhof, in which the old and decrepit employees are provided with charming homes, each

designed for a man and wife. These colonies are among the most attractive parts of Essen.

The system of parks in the new part of the city was laid out with a view of having one of the larger parks within five to ten minutes walk from any section, and this has been practically realized. The total park area is not large, as it was in 1910, only 7.4% of the total area of the city, or about 104 sq.ft. per inhabitant. Essen is, however, much better off in this respect than this figure indicates, due to the large tracts of woodland just south of the city and along the Ruhr River. This district can be reached in fifty minutes by foot or twenty minutes by trolley from the center of the city and so is readily acessible and is much frequented by the people of Essen. There were in 1910 46.8 sq.ft. of playgrounds for each child in the city.

Essen is primarily a city of low buildings, and the tendency seems to be for the height to decrease rather than increase. This is in part due to the great chance of damage to high or large buildings due to the settlement of the land over the coal mines by which practically the whole city is undermined. Evidences of this settlement

FIG. 7. A STREET IN THE KRUPP COLONY OF "ALTENHOF"

can often be seen in the old walls and buildings. The height of buildings in the city is distributed about as follows:

Four stories in height—10% of the total area.

Three stories in height—26% of the total area.

One or two stories in height—54% of the total area.

The group system of buildings has been well developed and has helped greatly to furnish variety in the street fronts. Steep tile roofs are usually used, as giving a more attractive appearance and individuality than the monotonous line of flat roofs prevailing in the solidly built up parts of so many cities.

The results have been obtained with the aid of a strict building ordinance, a liberal land policy and a concentration of power under one head. As in most of the German cities the city is divided into several districts according to the use of the land and the regulations for each district are somewhat different. A summary of the restrictions for maximum height and unbuilt areas follows:

	District 1	2	3	4	5
Max. height of buildings	18 meters	18 meters	16 meters	16 meters	16 m
Unbuilt portion of lot	25% (2 & 3 sto.)	30% (2 sto.)	35% (2 sto.)	40% (2 sto.)	50% (2 sto.)
	30% (4 sto.)	35% (3 sto.)	50% (3 sto.)	50% (3 sto.)	55% (3 sto.)
		40% (4 sto.)	55% (4 sto.)	60% (4 sto.)	

Ordinarily, the height of a building must not exceed the width of the street it fronts upon, although under certain conditions an additional two meters is allo

The great detail with which the plans have been wo out can be illustrated by two examples, which are by means exceptional. In Messelstrasse, one of the ho in a block of three-story houses was limited to two st in height so as to afford from a neighboring street a v of a large and handsome school building. Again, in plan recently made for an outlying section, arrangeme have been made with the evangelical church associati to build a large and monumental church at the propo intersection of five main streets.

The entire plan for the new sections of the city and the modifications of the old plan were designed and are being carried out under the direction of Beigeordneter Dr. R. Schmidt, the chief engineering official of the city of Essen, to whom I am indebted for most of the above statistics.

⁂

The Teredo in Fresh Water—Contrary to general belief the teredo may exist in fresh water, as the following experience proves: The United States snagboat "Waco" was built about three years ago of long-leaf yellow-pine, with rake planks of oak. Before launching the hull was painted with

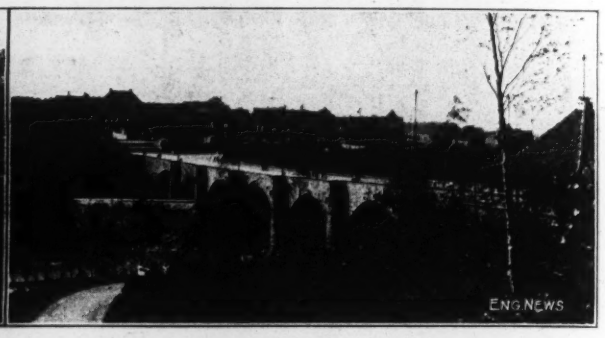


FIG. 8. A STREET VIADUCT CROSSING THE PARK

carbolineum. Soon after its completion at Jeffersonville, Ind., the "Waco" started on a trip to the Brazos River in Texas. Altogether the boat spent 2½ months in tide water, including the time working below Mile 40 in the Brazos River. The effect of the tide is perceptible up to this point, although there are no signs of barnacles or teredos in the wharves above Mile 20.

After passing Mile 40 the "Waco" spent the next two years and ten months working her way upstream to Mile 171, from which point she was recalled and hauled out for repairs. An examination of the hull planking was made and found to be fairly well honeycombed by the teredo, necessitating the renewal of all bottom planking and the greater portion of the gunwales. Some of the specimens of the teredo that were examined were ¾-in. in diameter and 18 in. long, all alive and healthy at the time the planks were removed.

The following analysis of Brazos River water, taken at Mile 418 shows a high percentage of salt, an amount 18.7 times that contained in samples taken from the Guadalupe River:

	Parts per million.
Iron and alumina	11.00
Silica	162.10
Calcium carbonate	460.50
Magnesium sulphate	120.00
Sodium sulphate	463.60
Sodium chloride	770.48
Alkalinity equals sodium hydroxide	14.00

It is possible that the gradual transfer of the "Waco" from salt water to fresh, together with the natural saltiness of the river, has been a factor in preserving the life of many of the teredos that had gotten into its planks.

There is no doubt that the specimens were genuine teredos, as they showed all the characteristic features, and the holes left by them were lined with calcareous matter. [R. G. McGlone in the "Professional Memoirs" of the Corps of Engineers and Engineer Department at Large, July-August, 1914, p. 560.]

The Old Cleveland Trainshed Roof

The remarkable old trainshed roof of the Union Passenger Depot in Cleveland, Ohio, whose demolition was described in our issue of June 11, 1914, pp. 1294-1297, was a relic of early days of iron framing that merited close study by all structural engineers. It was built in the days when combination cast-and-wrought-iron construction was yet in flower. Like many other combination structures, it was highly individual, showing original ingenuity in every part.

A separate source of interest is the fact that, though the safety of the roof was at all times precarious (or at least none too ample) judged by modern standards, the roof stood almost half a century without accident or trouble. Alarm was raised concerning the structure about 40 yr. ago—in 1877—and again in the '80's was it criticized. Besides being doubtful in its iron framing, its expansion and contraction rocked one of the two supporting walls—in default of good roller construction. At one time, too, a storm actually broke some parts of the rod tie-work in the roof. But it suffered no vital accidents, and has remained until taken down, 49 yr. after its construction.

Reproductions of the two old drawings of the roof trussing are shown in Figs. 2 and 3 herewith. So far as can be determined, these drawings were made at the time of construction—one of them undoubtedly before construction, since the roof itself exhibited several departures from the drawing.

General Description

The trainshed was 600 ft. long. The roof trusses, spanning 180 ft. and spaced 12 ft. apart, were of double-pitched outline and looked something like ordinary roof trusses. But they probably were arches, as all the web members, except one strut on each side, were tension rods, forming a sort of spiderweb bracing system that suggests rigid arch-rib action of the rafters or upper chord. The web system includes a main tie-chord, an auxiliary tie or middle chord, and various diagonal tension rods. The strut near the lower third of either rafter was simply butted to its connections at top and bottom; it probably took only the local panel-load, and had minor effect (if any) in bracing the rafter against arch distortion.

The general design is such as to defy stress-analysis.

Fig. 1. Interior of Cleveland Union Depot Trainshed, Looking along the Line of Struts
(Except for one strut on each side, all the web-members of the truss are tension members.)

But some approximate calculations lead B. R. Leffler, Bridge Engineer of the Lake Shore & Michigan Southern Ry., to state that the stresses in the truss may have been considerably in excess of 30,000 lb. per sq.in. under dead-load alone. He also states that the weight of iron in the roof is only half of what would be found in a structure of modern design, a fact which itself points to high stresses.

Top Chord or Rib

The rafter or arch rib, 21 in. deep, was made of four wrought-iron bars, 6 in. wide by about 5/8 in. thick, with

cast-iron cross-shaped spreaders or spiders between, held together by pairs of assembly bolts running through from bar to bar. The drawings show only upper and lower flange bars, but in the roof itself every arch-rib had also two side bars (Fig. 5). These were apparently afterthoughts, as noted below. They were held apart by two sets of cast-iron angle or filler blocks in the upper and lower forks of each spider, seated against the middle rib of the spider arms, and notched for two through-bolts.

The spiders in the straight part of the rafter were planed square on the eight abutting corner-faces. Those of the middle part had their radial faces planed to a constant taper, which made this part of the rafter a circular segment. An obtuse angle was formed at the junction of circular and straight portions, by a filler block at the upper flange, between adjoining spiders, welded to the upper flange bars.

The original plan (Fig. 2) appears to have contemplated using two narrow (2½-in.) bars each in upper and lower flange of the rib, instead of one 6-in. bar. The two westerly trusses of the trainshed were built this way, but all the other trusses had single 6-in. bars (Fig. 3).

The peculiar top-chord construction used in this roof was apparently used in some other buildings also. Old records of the Lake Shore at least seem to show this. But no structures embodying it are in existence today.

The spiking pieces for the roof planking were fastened to the top flange of the rib by the rib assembly bolts. Of the two bolts at each cross, one

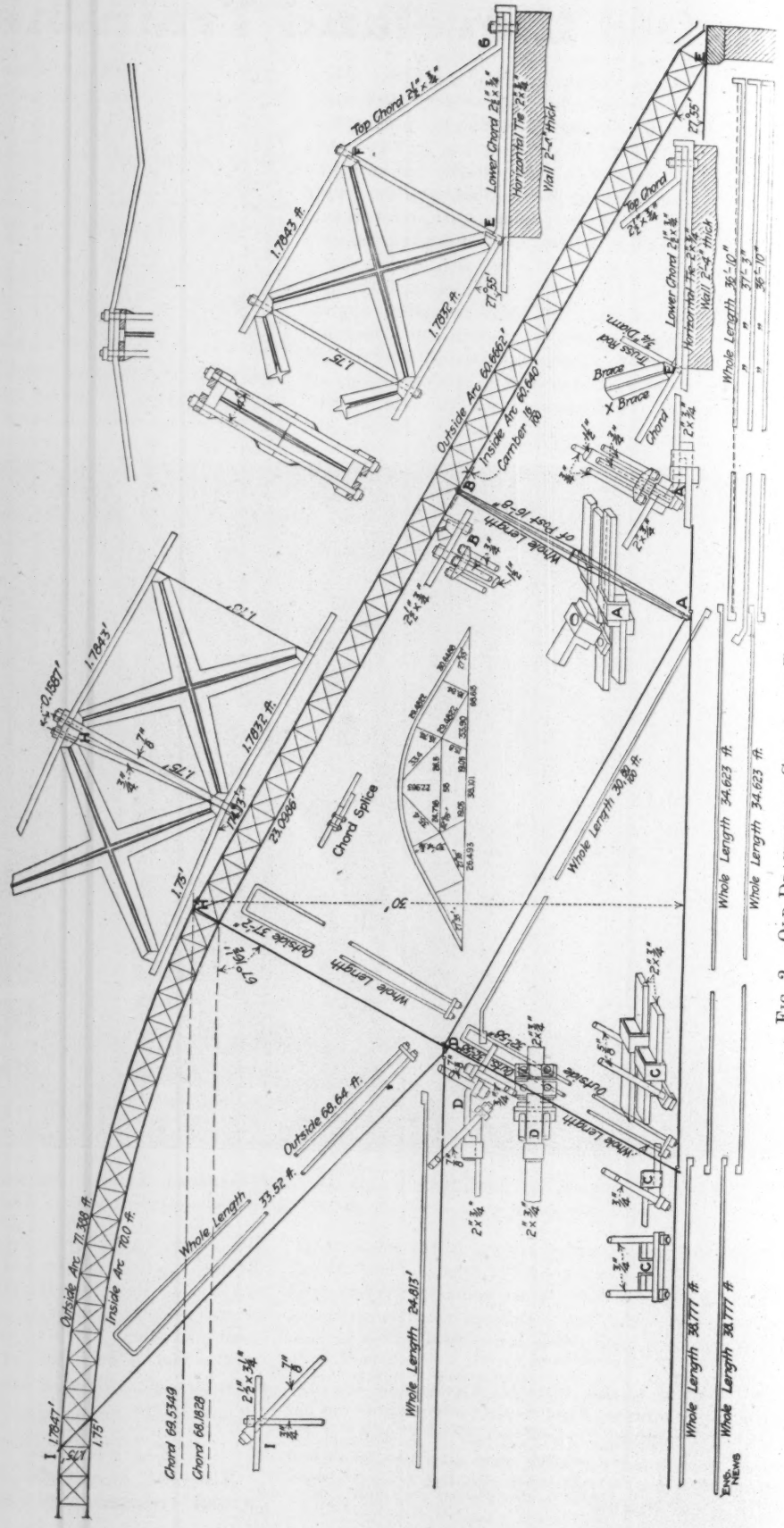


FIG. 2. OLD DRAWING OF CLEVELAND TRAINSHED ROOF

Title of drawing: "Iron roof truss, Union Passenger depot, Cleveland, January, 1865. Scale, ½ in. per foot. Scale of Details 3 in. per foot. [illegible]"

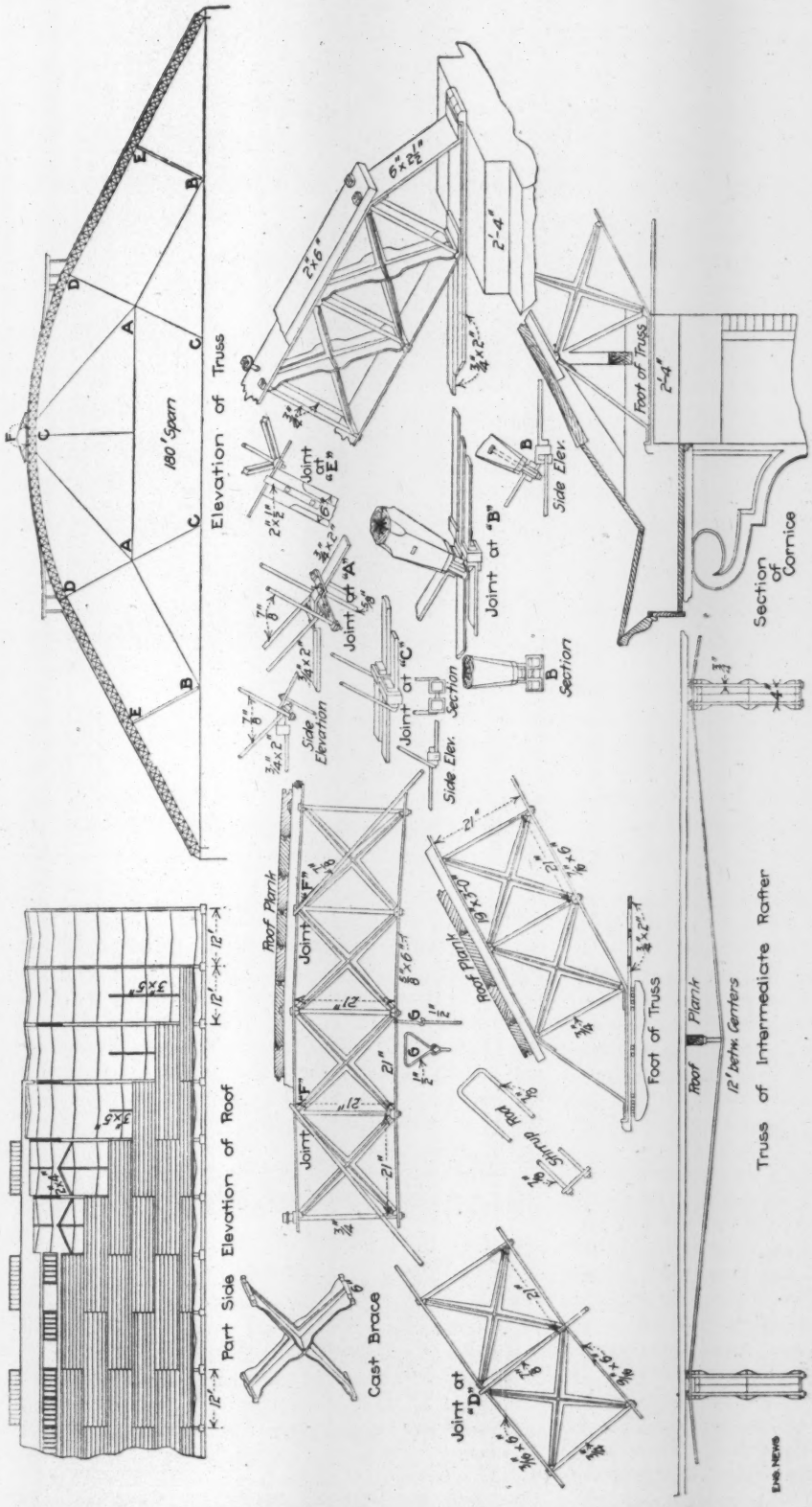


FIG. 3. DRAWING OF ROOF

Bearing title: "Iron roof truss, Union Passenger depot, Cleveland, Ohio."

had its nut raised about 2 in. above the top flange on a gas-pipe spacer, and this spacer passed through the spiking piece, and allowed the nut to secure it in place; the nut of the other bolt was seated directly on the flange bar.

The side bars, as already noted, were probably added after the roof was erected. Their most curious feature was a screw-joint at the beginning of the segmental crown portion. Here the pair of side bars of the lower part is terminated by a block between the bars, facing a similar terminal block of the side bars of the crown section. In the 5 or 6-in. space between the blocks was a right-and-left screw passing through both blocks, its middle part shaped to take a wrench. If these side bars were added some time after construction, to reinforce the ribs, this screw connection may have been used as a means of making the side bars share in the compressive stress carried by the rib.

Each rib was seated on and built into the wall masonry of the south wall of the trainshed, but at the north or lake-side wall was seated on a series of ¾-in. rollers, resting on the stone wall-plate. There was no evidence of motion at the roller bearing, and above the wall-plate the masonry was carried up to meet the roof planking, thus enveloping the arch ribs and tending to prevent expansion motion. This north wall was taken down in the demolition of the roof, and its masonry was found to be quite loose, i.e., not bonded by its mortar, and the horizontal joints of the wall in many places showed the en-

FIG. 4. INTERIOR VIEW TOWARD DEMOLITION TRAVELER, CLEVELAND UNION DEPOT

(At the extreme right is the line of web struts corresponding to that seen in the middle of Fig. 1. The entire middle part of the roof has only tie-rods in its web. The form and make-up of the arch rib are shown clearly in the silhouette of the far truss.)

trance of soot. From this it is believed that the trusses did not move on the wall, but that expansion and contraction of the ironwork was taken up by rocking of the wall.

The only strut in the web system (see Fig. 1) is shown in Fig. 2 as a 1½-in. iron rod trussed with four ¾-in. rods. It was built as a wooden strut, however, and Fig. 3 shows it so. The latter drawing is therefore evidently of later date than Fig. 2, but, as some details, e.g., the connection of the diagonal rods at the crown, are not quite the same as there shown, it was probably made before the roof was built—as a final construction drawing, perhaps.

TENSION MEMBERS

The lower chord and the auxiliary tie or middle chord were made of flat bars (1 to 3 in number). The splices in these bars were located at the joints of the web system, and were in all cases made as sketched in Figs. 2 and 3. Upset ends were forged, and these were hooked into each other and the joint then secured by slipping a welded square ring over the connection.

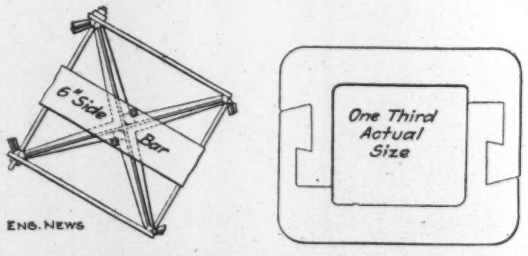
A curious reinforcement was found at all these joints. The welded wrought-iron ring was backed up by one or two split cast-iron rings, wedged tight on the joint by wrought-iron wedge shims. The adjoining sketch, Fig. 6, shows such a ring, traced from the object. These must have been added after the roof was erected, to strengthen the joint against bending due to its eccentricity of pull, i.e., to reduce the tension on the wrought-iron rings.

The minor tension members (except the crown hanger, a single ⅝-in. or ¾-in. rod) were double rods, connected to other members by yoke bars, as sketched in Figs. 2 and 3.

ROOFING

The 2-in. roof planking spanned 12 ft. between trusses, but with intermediate support by a jack-rafter. This jack-rafter had nothing to carry it except a trussed purlin formed by the roof planking itself and a truss rod, blocked against the jack-rafter, extending from arch rib to arch rib (Fig. 3). The truss rods, which were flat bars, corroded badly, some of them rusting entirely through and hanging from one end. The planking was able to span the 12 ft. without intermediate support.

The spiking pieces and roof plank were of white pine; the planks were fastened by wrought-iron nails. The covering was slate on tar paper, fastened with copper nails.



FIGS. 5-6. RIB REINFORCEMENT, AND CAST-IRON INTERLOCKING RING FOR REINFORCING THE TENSION-BAR SPLICES, CLEVELAND TRAINSHED

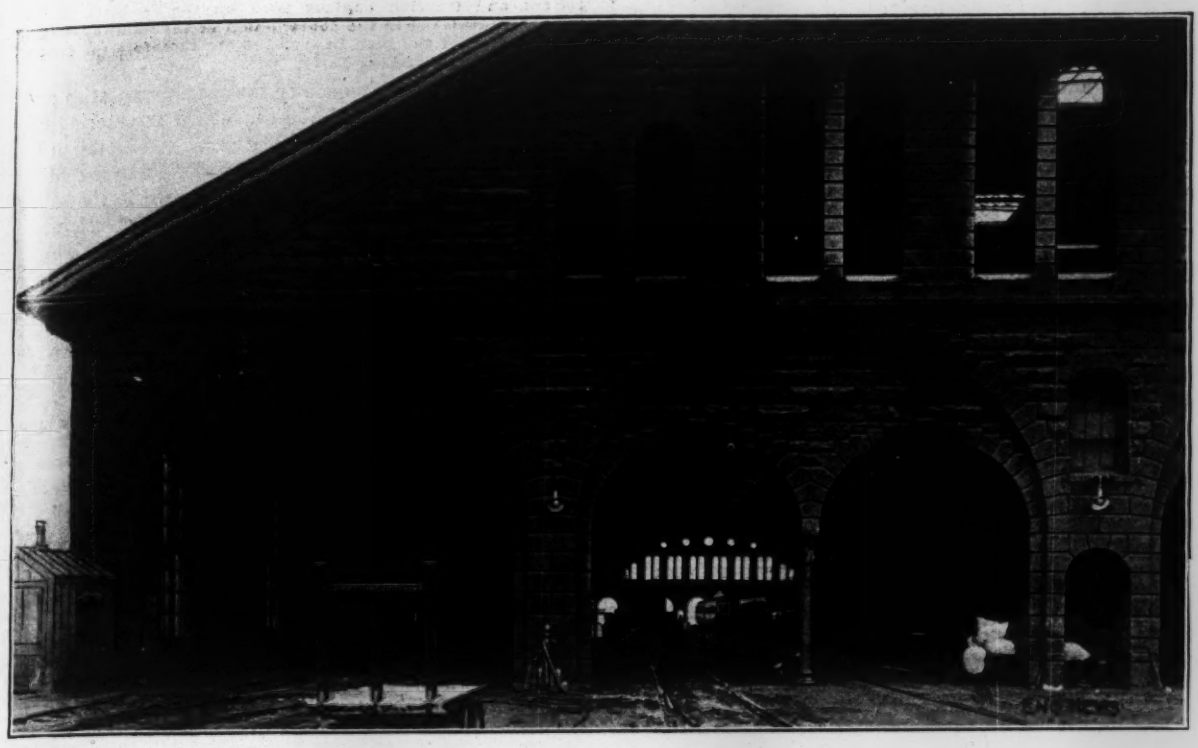


FIG. 7. WEST WALL OF CLEVELAND UNION DEPOT

(The narrow masonry piers, and the cast-iron intermediate columns with plain base and cap plates, offer little resistance to a colliding train, yet they stood the full 49 years since 1865 without harm. At some time in that period the north intermediate column was taken out to make room for a crossover; the north pier buckled, and timber centering was put in to support the arch.)

None of the roofing material had been removed during the life of this structure, and at the demolition it was found in excellent condition.

For further details, the drawings, Figs. 2 and 3, can be referred to.

One fact bearing on the action of the roof truss in carrying load is to be noted. About 40 ft. inward of the south wall there was a longitudinal wall inclosing the waiting-room, etc., for the whole west half of the trainshed. The brickwork of this wall extended up to the roofing, and where it came under the bottom flange of the rib the brickwork had been built solid up against the iron. In the demolition the upper part of this wall was torn out. The result was a small but measurable deflection, ¼ to ½ in., over the line of the wall, indicating that some of the roof weight had rested on the partition.

HISTORY

The front of the station building bears the date 1865, agreeing with the date on the first drawing (our Fig. 2). B. F. Morse, who died a few months ago, was Constructing Engineer for the structure. It is a remarkable coincidence that the train which carried his body to burial went through the trainshed on the very day when demolition of the old shed was begun.

Early records relating to the roof have not been found. A letter from Morse to John Newell, General Manager of the Lake Shore & Michigan Southern, written Mar. 26, 1877, is the earliest, aside from the two drawings here reproduced. Morse had become City Engineer of Cleveland in 1867, soon after completion of the trainshed, and was in this position at the time of writing the letter.

CRITICISM AND REINFORCEMENT

Mr. Morse's letter refers to criticisms of the roof, to a report made by a Mr. Wilson of Philadelphia, and to tests of some tension splices which the latter had made. It also relates that Mr. Morse made a private examination of the roof, and found the stress in the various tension joints to be not over 3 to 4 tons per square inch. He makes some suggestions for reinforcement; one of them shows (by sketch) side bars applied to the two lower panels of the rafter. This suggests that the side bars were added to the roof after 1877, and probably they were put on for the full length of each rafter, as found in the roof just demolished.

Later, in the early '80's, the roof was criticized and its strength declared doubtful, by S. W. Robinson, engineer to the Ohio Railroad Commission, but there is no record that anything was done to meet this criticism.

About 1885, a great north storm, blowing on the lakeside of the roof, broke a number of the crown diagonals on that side, at the same time buckling the corresponding south crown diagonals. The broken bars were replaced, and the roof appears to have suffered no permanent damage.

In recent years, the corrosion began to give trouble at some local points. As already noted, some of the jack-rafter truss-rods rusted through, but no attention was paid to this as the plank safely spanned the 12 ft. between trusses. But four years ago, in 1910, over a

point in the shed where engines of passenger trains stood more frequently and longer than elsewhere, the assembly bolts of the rafters the bolts (passing through from upper to lower flange plate) were found to be seriously weakened by corrosion. All the badly weakened bolts, in fact about one-fourth of all the bolts in the roof, were replaced, one by one, by steel bolts—the original ones were wrought iron. These rafter assembly bolts were important as they prevented the collapse of the rafter, and consequently that of the whole roof.

Last fall it was found that the new steel bolts were corroded almost as badly as had been the wrought-iron bolts, which they replaced, three years before. This fact made it clear that the problem of maintaining the roof was likely to become exceedingly difficult. A specially thorough examination of the roof, extending over two months (and not completed even in that time) further emphasized the difficulties attendant upon frequent close inspection and repair. With further regard to the indeterminate system of the trussing, and the probable high stresses existing in the main members, the engineers when called upon for definite assurances as to the safety of the roof declared the roof unsafe. Plans for its demolition were started at once, and were carried out during May and June, 1914.

Condition of the Iron

The ironwork of the roof shows almost negligible corrosion in its main members. The cast-iron spiders of the rafter are practically free from rust; the flange bars and large tension bars, while rusty, do not seem to have suffered much loss of section. The rafter-assembly bolts were much rusted, as noted above, and similarly the thin flat truss-bars of the jask-rafters and the crown hangers of the trusses lost much from rusting. These exceptions, however, form only a small part of the total ironwork of the roof. Considering the severe exposure to locomotive gases, steam and atmospheric moisture, the condition of the roof is remarkable. In those parts of the trusses south of the waiting-room partition, i.e., outside the open trainshed space, the iron is almost perfectly preserved, being hardly tarnished.

The woodwork of roofing, etc., is as well preserved as the iron. Its slate and tar-paper covering protected it fully from decay.

The removal of the old roof was wholly a safety measure, as the new Union Station now being planned for will be located half a mile or more to the eastward. The platforms of the old station are being covered by butterfly sheds pending completion of the new station.

The date for the preceding description were given by B. R. Leffler, Bridge Engineer, Lake Shore & Michigan Southern Ry., Cleveland, Ohio, who is in charge of the demolition work and previously was responsible for the maintenance of the roof. The copies of the old tracings were also obtained through his courtesy.

Coal, the Contractor and the Lien Law

An interesting decision was handed down in February by the New York Court of Appeals, to the following effect as stated in the headnote:

Coal sold to a contractor and builder of a state highway and consumed in generating steam in the boilers of road rollers and traction engines used on the contract, is not material furnished in the construction of the highway, within the meaning of the Lien Law and is not therefore the subject of a lien (Sec. 5 of Lien Law).

It happens not infrequently that arguments arise as to just what material should be considered as entering into construction work. In the case under consideration the point to be decided was whether coal sold to a contractor and builder of a state highway and used in the boilers of road rollers and traction engines on a contract, was a material furnished for the construction of the highway, within the meaning and intent of Sec. 5 of the Lien Law, which reads as follows:

A person performing labor for or furnishing materials to a contractor, his subcontractor or legal representative, for the construction of a public improvement pursuant to a contract by such contractor within the state or a municipal corporation, shall have a lien for the principal and interest of the value or agreed price of such labor or materials upon the moneys of the state or of such corporation applicable to the construction of such improvement, to the extent of the amount due or to become due on such contract, upon filing a notice of lien as prescribed.

The Court held that inasmuch as the coal was not applied directly to the highway or absorbed by it, the price of the coal in question was not a lawful subject for the lien.

In supporting its conclusions the Court referred to other important decisions on this same point. One of these decisions read:

We are of the opinion that there is a plain distinction between materials so used [coal burned in engines used on work] and materials that enter directly into the work and become a part of it, or those that are consumed by being applied directly to substances to be moved or changed to make a place for the structure or be incorporated into it.—[Sampson Co. vs. Commonwealth, 202 Mass., 326.]

The decision of the Court of Appeals on this point recalls other decisions in this same field. It has been held that materials used in a coffer-dam constructed especially to make possible the building of the dam contracted to be built and which were in effect destroyed by their use in the coffer-dam or subsequent use were the lawful subject of a lien.

As illustrating distinctions which must be drawn in defining materials used directly on road construction, other decisions of the New York Court of Appeals have held that dynamite used in breaking up frozen earth so that excavation could go forward was material furnished for the improvement of real property, and its furnishing the lawful subject of a lien. On the other hand, the rent of a steam shovel leased to a contractor for use in the construction of a public improvement, is not the lawful subject of a lien inasmuch as the machine after the construction work is completed is in practically the same condition as it was before the work was started.

The decision as regards the attachability of coal used in the operation of a contractor's plant appears to be very fair. Had the decision been otherwise, much confusion would follow, for it might be argued upon the same principle, that oil used in the lubrication of contractor's tools, and even food eaten by laborers and perhaps clothing worn by them, are all consumed in the construction of a building or other structure and hence are lienable materials. While this might all be true, such materials have neither physical nor immediate connection with the structure at any time. They are auxiliaries which make possible the operation of tools, machinery or men, which in their turn act upon the structure. This decision will probably be widely quoted.

Editorials

Commercial and Engineering Opportunities in South America

Never was there a more opportune time to press the introduction of American products in the development of the great engineering, mining and industrial enterprises of our South American neighbors. With all the other industrial countries of the world busy destroying one another, with no safe Atlantic merchant marine but that which plies between the American republics, the time has come for South America to turn to us for many manufactures which cannot now come from Europe.

Particularly timely, then, is the detailed account of the constructional activity of one of the most active of our Southern neighbors, a field which has already been extensively entered by American engineers and manufacturers. We recommend a perusal of the article on another page of this issue, "Recent Railway Construction in Chile," to manufacturers of railway and contractors' equipment. The author, Mr. King, has recently returned from a long business engagement in Chile, and has made his article specific enough to be of much value to live and foresighted American manufacturers.

It should be remembered, however, that Chile is but one of several of our prosperous South American neighbors who can no longer look to Germany, Belgium and England for locomotives, cars, steel and other equipment. When these South American countries once begin the extensive introduction of American products, let the manufacturers see to it that those products will ever afterwards be preferred.

With the right kind of commercial relations more friendly and intimate communication is inseparable, and the opportunity for American engineers to coöperate with their Southern brethren in great wealth producing enterprises must become greater than ever before.

An Object Lesson in City Planning

The average engineer, especially the engineer who has no connection with municipal work, probably regards city planning as a sort of amiable fad, with very little relation to the practical conditions and possibilities of American cities. If any such engineer, however, has the good fortune to visit the cities of modern Germany and view them with his eyes open, he soon realizes that city planning is something of enormous importance and enormous possibilities.

Elsewhere in this issue we publish an interesting account of what city planning has accomplished in the City of Essen, Germany, written for ENGINEERING NEWS, by Harold M. Lewis (son of Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City). Essen has become world-famous as the center of the great Krupp iron and steel industry. The Krupp works themselves form the nucleus about which the city has grown, and the shafts of numerous coal mines also emerge in the heart of the city.

Most American engineers know pretty well the appearance of the average American industrial town in the coal-mine and steel-making sections of Pennsylvania or Ohio; the long lines of dreary hovels in which the workmen live, the crude tawdriness of the business streets; the heaps of discarded tin cans; the tumble-down shanties and sheds; the barren hills and valleys surrounding. All these are only too familiar. The American who visits Essen, expecting to find there such sights as these, familiar in an American industrial city, has the surprise of his life awaiting him. Mr. Lewis' description and the photographs accompanying his article do faint justice to the beauty of streets and parks and buildings in this German city, where 90% of the workers earn less than $700 a year.

These beautiful results in city planning at Essen are obtained by comparatively simple means. Compare the variety in the street plan of Essen with the monotonous checkerboard regularity governing the layout of streets in almost every American city. Compare the narrow, well paved, well kept streets of Essen and their liberal provision of space for grass and trees, with the streets of the average American city, all laid out to one uniform width, and presenting usually a narrow strip of macadam or paving lined on each side with a broad stretch of weeds. Essen and other progressive German cities show the possibilities from *planning* a city's development, instead of letting it proceed on the plan of Topsy, who "just growed."

A Belief in a Shortage of Engineers

An Arkansas correspondent sends us an editorial in the "Christian Science Monitor," entitled "Why a Shortage of Engineers," containing the statement that "never before has the demand for civil engineers been so far ahead of the supply." Our correspondent remarks that from his own observations in recent travels over the country he found a situation exactly the reverse.

It should be added that the journal referred to based its statement as to the shortage of engineers on the report that the railway valuation work under the Interstate Commerce Commission was proceeding slowly because the U. S. Civil Service Commission had not yet been able to supply enough junior engineers for the work of surveying.

It is evident that the "Christian Science Monitor" has formed an opinion on very limited evidence. Those who are directing the work of railway valuation preferred to go ahead rather slowly at the start and test their methods by actual trial before putting parties at work in all parts of the country. There was at one time, in-

deed, some difficulty in securing certain men for special work on the valuation force under the conditions and the salaries offered; but it is a very far cry from such a condition to the conclusion that there is a shortage in the supply of civil engineers.

The Cost of Building the Panama Canal

The widely published official figures of the cost of the Panama Canal have possibly given the general public an exaggerated idea of the cost of the canal as a piece of engineering work. The statement has been made that the entire cost of the canal to the United States when completed will be in the neighborhood of $400,000,000, and it is a natural conclusion that the bulk of this expenditure has gone into the work of digging the canal and constructing the locks.

It will surprise many engineers even, we doubt not, to learn from figures published in the last number of the "Canal Record," that up to Mar. 31, 1914, the entire expenditure on the canal in the Department of Construction and Engineering had been only $204,087,000. The total expense up to the same date for all purposes connected with the canal was $322,659,000. The chief items in the account, apart from construction and engineering, were in round numbers, civil administration, $7,000,000; sanitation, $17,000,000; fortifications, $5,000,000, and general items, $90,000,000. Under this latter head are included the payment of $40,000,000 to the French Canal Co. and $10,000,000 to the Republic of Panama. There is also included under this head very heavy expenditures for the reconstruction of the Panama R. R., the construction and repair of buildings and the cleaning up of the cities of Colon and Panama. Of course, all these expenditures were necessary to the canal work, but it ought to be more generally understood that in the actual building of the canal, including the cost of the machinery used in its construction, the entire expenditures have only been, in round numbers, $204,000,000.

Rerailing Frogs Protect Bridges

Derailment of a train is serious enough anywhere along the railway line, but it is most serious when approaching or upon a bridge. For a long time it has been the ideal of bridge engineers to make the roadbed just as safe over a bridge as it is elsewhere; to create structures which will carry the normal roadbed across the opening in such a way that both the operating department and the maintenance department need in effect never know that a bridge is there. Perhaps that ideal may be reached in the future. At present we are still very far from it. Means for protecting trains from the special danger of a derailed truck or axle on a bridge have therefore been often discussed, time and time again, beginning many years ago.

ENGINEERING NEWS only a short time ago [Apr. 23, 1914, p. 930] suggested that in many cases a marked advantage may be secured in the direction of safety by erecting fender or buffer piers along the track or at the approach to a bridge. This introduced a distinctly new element into the discussion. The Harrison wreck on the New Haven and the Attica bridge wreck on the Wabash, gave special point to the suggestion. Now comes news that a less radical and more generally known expedient offers such increase of safety as to make its adoption a plain matter of good business.

The danger of derailments on a bridge lies not only in the chance that the projecting car may strike the trusses and thereby break down the bridge, but also in the probability that the derailed truck or axle will tear up the bridge floor. Rerailing frogs, placed in the inner guard-rails on the approach to the bridge, eliminate this danger by catching the derailed wheels and guiding them back to place on the rails. The Pittsburgh & Lake Erie Ry. uses this arrangement at nearly all of its bridges. The experience of that railway, we learn, indicates that the rerailing frogs are effective in taking care of derailed wheels. The track-inspection men report, from time to time, that marks of derailment show on the track, and that they disappear at a rerailing frog; clear evidence that a derailed axle was prevented from doing extensive damage to a bridge, with the chance of wrecking a train.

A single train wreck may easily cost more money than enough to place rerailing frogs at all the bridges of a fair-sized railway system. If one wreck a year is prevented by them, are they not a good investment?

The Utilization of the Catskill Water-Supply in New York City

It is expected that the new Catskill water-supply will be available for distribution in New York City by Jan. 1, 1916. A report has recently been made by I. M. de Varona, who has just been retired as Chief Engineer of the Department of Water Supply, Gas and Electricity, of New York, setting forth a proposed plan for the utilization of the Catskill supply by the city.

Contrary to the popular belief, the volume of the new Catskill supply now developed will be less than that now taken from the Croton watershed. Croton water, therefore, will continue to be used and the Catskill supply will serve to supplement it. The area of the Croton water-drainage area is 360 sq.mi. The area of the Esopus drainage area, the only part of the Catskill water-supply now developed, is 255 sq.mi. Eventually, however, it will be possible to supplement the supply from the Esopus watershed with water from the Rondout, Schoharie and Catskill drainage areas, with an additional area of 522 sq.mi. This will make a total area available on the west side of the Hudson River of 777 sq.mi.

Mr. de Varona's report, however, deals only with the Esopus water-supply soon to be available. The estimated safe yield from the Esopus is set at 250,000,000 gal. per day. This may be compared with the 336,000,000 gal. which is the estimated safe yield of the present Croton supply, and 150,000,000 gal. per day which Brooklyn now receives from its driven-well system on Long Island. The most important feature in connection with the new Catskill supply is that it will be delivered to the Borough of Manhattan at a head of 295 ft. above tide water.

The present Croton supply comes to the city at so moderate a head that large areas of the city located on high ground have to be supplied by pumping the Croton water. The Brooklyn supply being from driven wells, all requires pumping. The first use of the Catskill water, therefore, will be to supply the high areas in all the bor-

oughs and do away so far as possible with the expense of operating pumping machinery. In the accompanying two tables, Mr. de Varona summarizes the water consumption in each section of the different boroughs supplied at a different pressure, and in the second table he indicates the future supply for each of these various services.

Based on the estimated consumption for 1915, the water consumption for the various services in the different boroughs of New York is shown in Table I.

TABLE I.

Borough	Service	Elevation of normal water-level, ft.	Estimated consumption m.g.d.
Manhattan	Tower	336	0.5
	High	280	26
	Intermediate	218	66
	Low (*)	119	173
Bronx	High	290	15
	Intermediate	193	33
	Low (*)	134	22
Brooklyn	High	260	12
	Intermediate	200	16
	Low	172	108
Queens, 1st and 3rd wards	High	250	16
Richmond	High	453	1
	Intermediate	330	3
	Low	228	9

Table II shows the order and distribution of the sources of supply for each service after the introduction of the Catskill supply, the selection being based on hydraulic gradient and cost.

TABLE II.

Borough	Service	Primary source (*)	Secondary source
Manhattan	Tower	Catskill pumped	Catskill pumped
	High	Catskill full pressure	Catskill
	Intermediate	Catskill reduced pressure	Croton pumped
	Low	Croton	Croton
Bronx	High	Catskill full pressure	Catskill full pressure
	Intermediate	Catskill reduced pressure	Croton pumped
	Low	Croton	Croton
Brooklyn	High	Catskill full pressure	Catskill
	Intermediate	Catskill reduced pressure	Catskill
	Low	Catskill reduced pressure	Brooklyn system
Queens	First ward	Catskill full pressure	Catskill or Bklyn. system
	Third ward	Catskill full pressure	Queens system
Richmond	High	Catskill pumped	Catskill
	Intermediate	Catskill pumped	Catskill
	Low	Catskill full pressure	Southfield Blvd. station

(*) Primary source is the supply to be utilized in 1916 for the given service. The secondary source is the supply that will be drawn on when the increased demand necessitates a re-adjustment of the sources of supply.

It will be seen from these tables that Catskill water will be utilized to supply all of Brooklyn, Queens and Richmond, and all of Manhattan and the Bronx, except those areas now on the low pressure. These low-pressure areas, however, at present use about 195,000,000 gal. of water per day, so that they will form an important part of the water consumption. This will leave nearly 150,000,000 gal. a day of the Croton supply and the entire Brooklyn driven-well system available to supplement the Catskill supply whenever increasing water consumption makes it necessary.

It must be remembered that the 250,000,000 gal. estimated as the safe yield of the Esopus watershed is estimated on the basis of what it will yield year in and year out, including seasons of extreme drought. Inasmuch as the city has the large storage of the Croton watershed and the Brooklyn driven-well system to fall back upon in case of emergency, it will be feasible to draw a much larger supply than this from the Catskill watershed without serious danger.

In addition to this, Mr. de Varona recemmended, in a report made to the Commissioner of the Department, on Nov. 21, 1913, that pumping machinery be installed to raise the pressure of the Croton supply, especially in those areas of the city where the height of the buildings necessitates the general use of pumps and tanks by the individual consumers. It is estimated that not less than $1,000,000 per year is spent by water consumers in this district for repumping the Croton supply to force it to the higher stories. The additional pressure upon the supply in this district resulting from installing city pumping stations would also increase the efficiency of fire-protection all over this area, which includes many congested-value districts not already covered by the high-pressure fire system.

It may very likely seem that the new water-supply from the Catskills will furnish such an unlimited amount of water that it can be used and wasted *ad libitum*. If this idea prevails, however, it will be a very short time indeed before New York will have to start up the pumping machinery which will be laid aside when the Catskill supply is introduced and only a very few years before the danger of water shortage will again menace the city.

Mr. de Varona presents a table showing the estimated average consumption of Greater New York from 1915 to 1925, assuming that no introduction of water meters and no systematic waste prevention are undertaken after the Catskill supply is introduced. The total available supply from the Esopus, Croton and Long Island drainage areas, with the small amounts from the Bronx and Bryan Rivers and the local water-supplies used in the Boroughs of Queens and Richmond, totals a safe yield of 766,000,000 gal. per day. Mr. de Varona's tables show that in 1920, only four years after the introduction of the Catskill supply, the water consumption of Greater New York, assuming as before that waste goes on unrestricted, will be 775,000,00 gal. per day, or greater than the safe yield of all the supplies now available. If, however, New York City will proceed with the introduction of water meters to restrict its waste, then Mr. de Varona estimates that the combined supplies now available will be sufficient until the year 1925.

This means, however, that in a very few years the city will again have to go to the expense of pumping a large part of its supply. The only way to obviate this would be to proceed with the development of the Schoharie, Rondout and Catskill supplies to supplement the flow of the Esopus. These can be developed at comparatively small expense and the aqueduct from Lake Ashokan in the Esopus watershed to New York City has been made of a capacity sufficient to carry the water from these additional drainage areas. These three additional areas will contribute a safe yield of 234,000,000 gal. a day to New York City. If waste is allowed to proceed, however, and water meters are not introduced, even this additional vast amount of water will be all required by the year 1926, according to Mr. de Varona's figures.

It is clearly evident, therefore, that New York should proceed at once to supplement the flow into Lake Ashokan by driving the Schoharie tunnel. It should also proceed with the introduction of water meters over the entire area of Greater New York. The total cost to the city of the water now supplied to the various boroughs averaged $48.80 per million gallons. The total cost of the Catskill supply from the Esopus watershed will be $97 per million gallons. This cost will be very greatly reduced, however, when the flow through the Catskill aqueduct is increased by the addition of the water from the other Catskill drainage area.

It is entirely clear that New York's great and costly water-supply ought to be carefully conserved. Abundant though it seems to be, the wisdom of proceeding diligently with the introduction of water meters and measures to prevent waste is proved by Mr. de Varona's figures.

Letters to the Editor

Air Valves on Water-Supply Lines

Sir—The discussion concerning air valves on water-supply mains, in your issue of July 30, is interesting and valuable. The writer agrees thoroughly with the main conclusions of Mr. Berry. As a corollary he remembers a case where a pipe some two miles long, extending from a pumping station to a reservoir, was full of water. The gage pressure at the pumping station indicated 120 lb. per sq.in.; no water was being supplied by the main, and the pumps were stopped. A valve near the reservoir was closed and immediately the pressure dropped in the pumping station from 120 lb. down to 105 lb., although the valve was at the same elevation as the water in the reservoir. This illustrates the simple phenomenon that might ordinarily be overlooked, that as soon as a valve is closed tight on a single line, in which no flow of water occurs, the pressure at the low point will immediately drop to that which would be caused by the highest elevation of water between the valve and the gage, less the atmospheric pressure. If the main were absolutely tight, the pressure would doubtless remain at the original amount, but the slightest leakage, which exists in all practical cases, would produce the phenomenon above described.

J. W. Ledoux,
Chief Engineer, American Pipe & Construction Co.,
Philadelphia, July 31, 1914.

Promoting Safety on Construction Work in Wisconsin

Sir: An editorial in Engineering News of July 16, suggests that greater attention to the safety of workmen on construction jobs will result from New York's new Employer's Liability Law. In Wisconsin, some of the opinions and predictions of that editorial have already been verified by experience.

In Wisconsin, both factory inspection and the administration of the Compensation Act have for three years been carried on by the Industrial Commission. Until recently the time and money available for safety work have been directed toward the prevention of accidents in shops and factories; this year the Commission has started a similar campaign in construction work.

Only a small percentage of accidents can be prevented by law, which is, however, a necessary foundation for further work. The Wisconsin law simply requires that all places of employment shall be made safe; the Commission is to fix reasonable standards of safety. The "General Orders on Safety in Building Construction" (only 20 in number, and very brief) were drawn up by an advisory committee, composed of four building contractors and four labor-union representatives. The orders cover the following subjects: Scaffolds; openings in floors; ladders; elevators, derricks and other machinery; temporary floors on skeleton buildings; piling of material; notes on stepping on nails, and first-aid outfits.

The enforcement of these orders requires inspection. Such inspection—and in fact the entire department—must not only be nonpolitical, but must be free from any violent partisanship as between capital and labor. Inspectors must be men who understand that the success of their efforts consists in arousing the sympathetic interest of the employer in safety, rather than in detecting technical violations of the law.

The Commission's records show that over 80% of building accidents are caused by carelessness. Such accidents cannot be prevented by laws or by mechanical safeguards only.

The Commission has distributed a "Safety First" poster suitable for posting on the job, containing simple instructions to workmen regarding the most common causes of accidents. Every month it sends out copies of typical accident reports, which especially illustrate the disastrous effects of carelessness. These reports also can be posted on the job.

The best way to secure the interest and coöperation of workmen in eliminating carelessness and reducing accidents, is to give the workman an active part in promoting safety. On a small construction job the "safety organization" may consist simply of one man in each gang, appointed as safety inspector to report all dangerous conditions to the foreman. The man chosen for this work must naturally be reliable and observing and should preferably be one whose duties take him about the job. This plan is now being tried out in Milwaukee. On larger work there should be frequent meetings of the different foremen to take up questions involving more than one gang, such as ironworkers dropping tools or rivets on masons below.

On a large job a safety man might well be employed. In large industrial plants the safety man is now recognized to be just as necessary as the master mechanic or the chief electrician. He acts as secretary of the central committee and keeps track of everything on the job which pertains to safety.

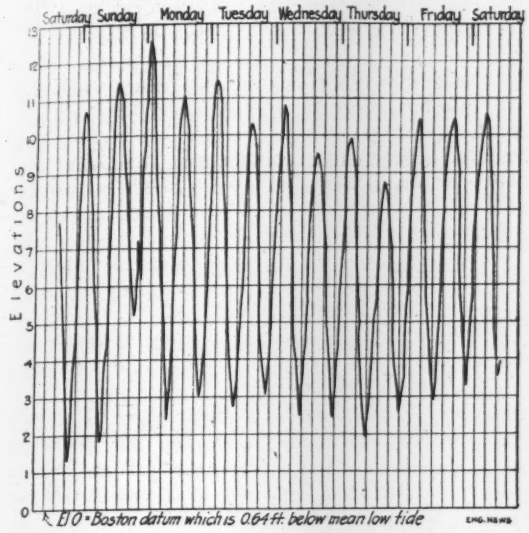
Sidney J. Williams, Building Inspector,
Wisconsin Industrial Commission.
Madison, Wis., Aug. 4, 1914.

Abnormal Tide Fluctuation at Boston

Sir—Although a continuous record of the height of tide-water in Boston Harbor, at the Charles River Dam, is kept by means of an automatic water-stage recorder, the man on duty on the wall of the lock is required to observe the stage of the tide every half-hour and to enter it in a book.

When, one Monday morning, early last March, the lock operator examined the book and found that, during the

previous night, the tide had apparently failed to go down to the normal stage of a low neap tide by 2½ ft., and that after rising 2 ft., it had apparently changed its mind and gone down again more than a foot before finally ris-



TIDE RECORD AT CHARLES RIVER DAM, BOSTON, FEB. 28-MAR. 7, 1914

ing, and that in addition, when it did come in, it rose to the height of a spring tide before receding, he quite naturally accused the observer of inability to read the height on the gage board.

The lock-man maintained that he was right and the dispute was settled by examining the automatic gage record shown herewith, which showed that the peculiar fluctuation had actually taken place.

The explanation is, of course, that a strong easterly wind, by blowing the sea-water in, first prevented the tide from flowing out and that it caused a small rise in the upper harbor before the tide actually turned. A slight subsidence in the wind then permitted an ebb which was soon overcome by the incoming tide which, also on account of the assistance of the east wind, proceeded to rise to a greater height than is usual for neap tides. The wind had stopped by Monday morning and the tidal fluctuations again became normal.

E. C. S.

Boston, Mass., July 28, 1914.

The Cleveland Municipal Electricity Rates

Sir: Responding to an implied invitation to criticize the figures in ENGINEERING NEWS, July 30, upon Cleveland's new municipal electric plant, I beg to ask if the total cost of the power plant of $50 per kw. of capacity means the installed capacity of 25,000 kw., or the commercial capacity to deliver energy to the switchboard for distribution and use? The figure of $50 per kw. would indicate that the former is the case. If so, I submit that it is not good practice to undertake to deliver the installed capacity of the plant, and if I am correct, the cost per kilowatt of the true capacity of the station is in excess of $50, by an amount depending upon the figure which represents such true capacity.

Is there not an error in the figure of 0.52c., which is given as the cost of distribution alone in the case of the Brooklyn plant? If, as stated, the total operating cost of both generation and distribution for the Brooklyn plant last year was 1.49c. per kilowatt-hour, and of this the station cost was 0.79c., the cost of distribution alone should be 0.7c.

There are other criticisms which may be made of the figures used, some of which are noted in the article. There also seems to be an opportunity to criticize the ethics of the proposition that a business having been developed by private capital, a municipality should by competition in such business force rates to a basis determined solely by the cost of construction and operation of the most modern facilities for performing the service.

FRANK SILLIMAN, JR.

Philadelphia, Penn., Aug. 6, 1914.

[The 0.79c. mentioned by our correspondent above should have been printed 0.97c., as noted later on the same page. This leaves the 0.52c. as correct. In regard to the other parts of the letter, it should be noted that the discussion in question attempted only to present, so far as we could ascertain, the tangible basis on which the Cleveland officials based their hopes of financial success with their 1c.-3c. electricity supply.

There are numerous obvious manipulations of the figures there presented, which may be of interest in further examining the chances of success, although it was not considered desirable to make all the possible arrangements. Among such is the proportion of installed station capacity to be considered as a reserve. Further, taking the figures used, assessing fixed charges on peak-load customers only, and assuming initial conditions of supplying only peak-load energy, the estimated cost per kilowatt-hour then will approach the maximum rate imposed.

Beyond this, there may be some problematical capital expenses only hinted at in our discussion, as where it was noted that the private company had attractive rates for off-peak power and that such business would have to be fought for by the municipal department. Such a struggle means investment in "going concern," which the municipality must make—willingly or not. The company now possesses the business and presumably has capitalized a certain cost of building it up. The new plant comes into the field unencumbered by such a capital burden, but also handicapped by lack of its opponent's favorable business; to improve its load the city plant must assume the expense of building up new business. A plant like this cannot altogether work on a basis of original cost, without burdening the taxpayers.

On the ethical side, of course, if a company has really been denied the privilege of amortizing dead capital expenditures and cost of intangibles, it does not seem common justice to let a competitor step into a fully developed industry. But in the absence of specific denial of the amortization privilege, failure to secure the needed sums out of earnings would seem to be chargeable against the ability of the managers. If a company has not been able to secure the desired amortization fund out of its earnings and still to make attractive prices, but hopes to be able to recover sooner or later, then it should frankly state its case to the public before or as soon as destructive competition begins to loom up.—ED.]

The 200,000-Hp. Development of the Mt. Shasta Power Corporation on the Pitt River, California

Brief mention was made in ENGINEERING NEWS, July 16, 1914 of a seven-mile tunnel being built by this company as a part of a hydro-electric power project. The following information has since been secured on the other features of this development.

FIG. 1. GENERAL LOCATION OF PITT RIVER DEVELOPMENT, RELATIVE TO SACRAMENTO VALLEY AND COAST CITIES

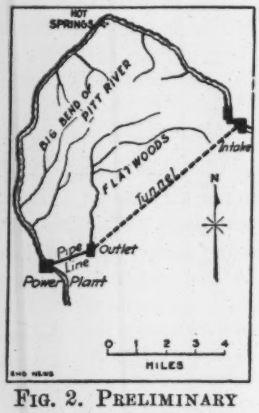


FIG. 2. PRELIMINARY PLAN OF RIVER DEVELOPMENT

The corporation is not given in current lists of public utilities, etc., so that its status has remained hidden to many. It is interesting to note, therefore, that the company was incorporated in California in 1912 by C. L. Firebaugh, Jos. Haber, Jr., A. M. Moore, and Edgar Sinsheimer, Lilienthal, McKinstry & Raymond being the attorneys. The capitalization was then placed at $10,000,000.

The location of this proposed plant is on the Pitt River near Redding at the head of the Sacramento valley. Its

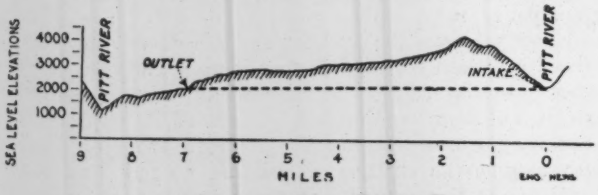


FIG. 3. PROFILE OF PITT RIVER TERMINAL

location places it in position to furnish power for the mining interests and mountain railroads to the north, and to the various industries in the cities and towns of the Sacramento valley as far south as Oakland, a transmission distance of 224 miles.

The plan of development involves the construction of a tunnel 36,753 ft. long. From the tunnel outlet the water may be conveyed in a pipe, or open conduit and pipes, to the power house, a total distance from the intake portal of a little less than nine miles. The static head is 939 ft., and the minimum discharge of the river taken from daily gage readings for the past six years is 2450 sec.ft. In 1902 the flow was 2560 sec.ft.; in 1903 it was 2830 sec.ft. The power in the minimum flow is 26,500 hp., and it would require only 76.5% efficiency of turbines and generators to secure 200,000 hp. at the feeders; with ordinary transmission losses, 175,000 hp. should be the possible delivery to San Francisco. The designed tunnel section, 16x19 ft., will carry more than the minimum flow.

Water rights were located in 1906, since when extensive surveys have been made, lands purchased, and riparian rights acquired covering practically the entire length of the river between the intake portal and power house, a distance of about 20 miles. Work has been started on a 7x8-ft. heading at each end of the tunnel and a little more than one mile of these headings has been driven. Air compressors, ventilating fans, electric lights, etc., operated by water power have been installed at each end of the tunnel. The company with W. A. Cooper, San Francisco, as Chief Engineer, is pushing its construction and arranging plans to deliver power to meet certain market demands which it expects.

In accordance with present designs, the Pitt River development promises to be one of the few 200,000-hp. plants; it should show the shortest conduit per horsepower capacity in California, the longest tunnel in this country and the largest in the world for water power.

An Automatic Petroleum-Tank Fire Extinguisher*

An automatic tank-fire extinguishing equipment consisting of standpipes placed around and connected to the storage tank, as shown in Fig. 1, was recently tested with satisfactory results, at the Bayonne, N. J., refinery of the Standard Oil Co.

The first test was run on July 22 in connection with a roofed tank 40 ft. in diameter. The fire apparatus consisted of four standpipes 30 in. in diameter, the same

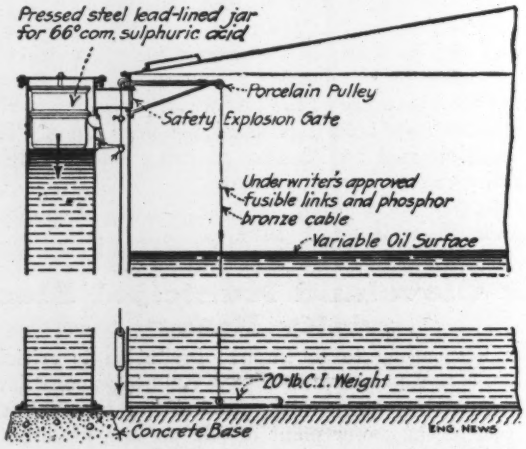

Pressed steel lead-lined jar for 66° com. sulphuric acid
Porcelain Pulley
Safety Explosion Gate
Underwriter's approved fusible links and phosphor bronze cable
Variable Oil Surface
20-lb. C.I. Weight
Concrete Base
ENG. NEWS

FIG. 1. ERWIN FIRE EXTINGUISHER FOR OIL-STORAGE TANKS

height as the tank, arranged outside and against the tank at intervals of 90 deg. There was a direct outlet into the tank from the standpipes, about 12 in. wide by 8 in.

*Information furnished by Charles S. Swarts, General Manager, Irwin Co., Milwaukee, Wis.

Fire at its height — One minute 30 seconds later

FIGS. 2-3. FIRE EXTINGUISHING TESTS AT BAYONNE, N. J., JULY 22.

deep, at the top of the tank. These standpipes contained about 1 gal. of a solution of sodium carbonate and soap bark per square foot of oil surface. Lead-lined sulphuric acid containers were suspended from the top of the standpipes, and connected to a phosphor-bronze cable containing standard fusible links, controlled by a series of triggers. The cable and fusible links were arranged to permit frequent inspection.

In the test, water was admitted to the tank to within 3 ft. of the top; 3000 gal. of Mexican crude oil and some naphtha were floated upon the water, and a torch applied. When the fuses melted, the acid dropped into the chemical solution in the standpipe and the resulting foam started instantly into the tank through the opening. The fire was automatically extinguished in 9 sec. by a 14-in. layer of foam.

On July 24, another test was run, in which the fire was permitted to gain headway (Fig. 2). The roof and automatic devices were removed, and the standpipes arranged to operate by hand on a 75-ft. cable, so that the acid could be released at will. The water in the tank was lowered 6 ft. It was thought by some that the foam in issuing from the discharge opening would be destroyed to a certain extent, and that its swift delivery across the surface of the oil would be impossible. On the water in the tank, 3000 gal. of Mexican crude oil and 100 gal. of gasoline were floated and ignited. The fire was permitted to rage for five minutes, when one of the standpipes was operated. It made little impression. The remaining standpipes were released 30 sec. later and the fire was extinguished in one minute (Fig. 3).

⁂

A Visible Interstate Boundary Line—As probably almost every reader knows, the city of Texarkana is on the interstate boundary of Texas and Arkansas. An enterprising local newspaper suggests making use of this unusual feature as an advertising asset; it says:

This state line we have running through our city, instead of being a source of contention and misunderstanding, if properly appreciated could be made the basis of a business condition which few other cities of America have the privilege of using.

Some time ago it was suggested that as an advertising feature, it would be a good idea to lay a row or two of white brick up the state line and across Broad street to indicate to visitors just where the line really is located.

FIG. 4. APPEARANCE OF FOAM AFTER SEVERE FIRE

In this connection it was suggested by one of the members of the improvement committee this morning that when State Line Ave. is paved, it being understood that the character of paving on both sides would be in conformity, it would be a good idea if a line of different color could be placed in the center of the street on the state line, and extending from the depot to the postoffice.

This recalls the aerial voyage of Tom Sawyer and Huck Finn; after traveling all night there was some question whether they had passed over the State of Illinois, but the point was settled by the green landscape; they hadn't made the Indiana line yet because in all the geographies they ever studied Indiana was pink, and Illinois green.

Progress of Work on the New Buildings of the Massachusetts Institute of Technology

At the time the accompanying photograph was taken, July 31, the concrete foundations of the new buildings of the Massachusetts Institute of Technology in Cambridge, Mass.,* were practically all in place. The amount of this work may be gaged when it is remembered that the sum of the axes of the various buildings is between 2500 and 3000 ft. For these foundations, piles have been driven for all outside and interior walls and for piers. A considerable part of the concrete work for the walls to the level of the first floor was also in place.

Work was held up for a time by changes in the original scheme of construction, which was to carry on the work on all the buildings simultaneously. A court decision in the spring, however, made it impossible to dispose of two of the present buildings in Boston advantageously, owing to existing restrictions, or of the laboratories at Trinity Place, due to real estate market conditions. Certain departments will therefore be housed in the present buildings longer than anticipated, so that certain units in the new buildings will be omitted for the present. The schedule calls for the roofing of the buildings now under construction by Christmas.

To July 31, about 20,000 piles had been driven, and 3000 more are to be placed for the library-building foundations. About half of all the piles are 50-ft. hard pine and the other half are oak, 35 ft. long. Each pile is designed to carry a load of 10 tons.

The new buildings are on made land, and preliminary to construction, extensive tests and investigations were carried out to determine its bearing power. The determination of the character of the subsoil was undertaken by Prof. W. O. Crosby, a graduate of the Institute, who was consulting geologist for the Catskill aqueduct, New York. He made a systematic subsoil survey by means of 62 borings. Prof. Crosby's report shows that in the vicinity of the present land a tongue of gravel extended into an old glacial lake. The Institute grounds are largely clear of peat, which was apparently extensively formed on neighboring areas.

Incidental to the work of construction, the contractor, the Stone & Webster Engineering Corporation, also made a series of investigations, including about 33 additional borings to a depth of 80 ft. Besides these about a dozen other borings were made in the vicinity, outside of the Institute grounds. At present, 12 other borings are being made within the foundation lines for the new library building, to determine the areas of hard driving.

Besides soil borings a series of tests were made on the bearing power of piles, 68 tests in all. Ten concrete piles were tested to loads up to 100 tons each. Wood piles were tested up to loads of 45 tons each. Only wood piles were adopted for construction. Some of the piles are driven to 55 ft., but the average depth of the glacial drift is from 12 to 30 ft. In addition to the tests already noted, 8 piles driven at random for the foundations themselves were tested.

SITE OF THE NEW BUILDINGS AND PLANT OF THE

(Looking toward Cambridge on the north from Massachusetts Ave.)

For convenience in construction, the buildings have been parceled out into groups of eight. Each of these groups or sections has its own headquarters, engineers, foremen, workmen and outfit. There are trestles, sandpits, railways, concrete mixers and towers, and the full equipment of each construction section is practically independent. In the lumber yard, near the center of the photograph, are nearly 1,000,000 ft. b.m. of stock. Here there is a sawmill, and altogether about 125 men have been kept busy making forms for concrete work. A mile of railway track makes every facade approachable for freight.

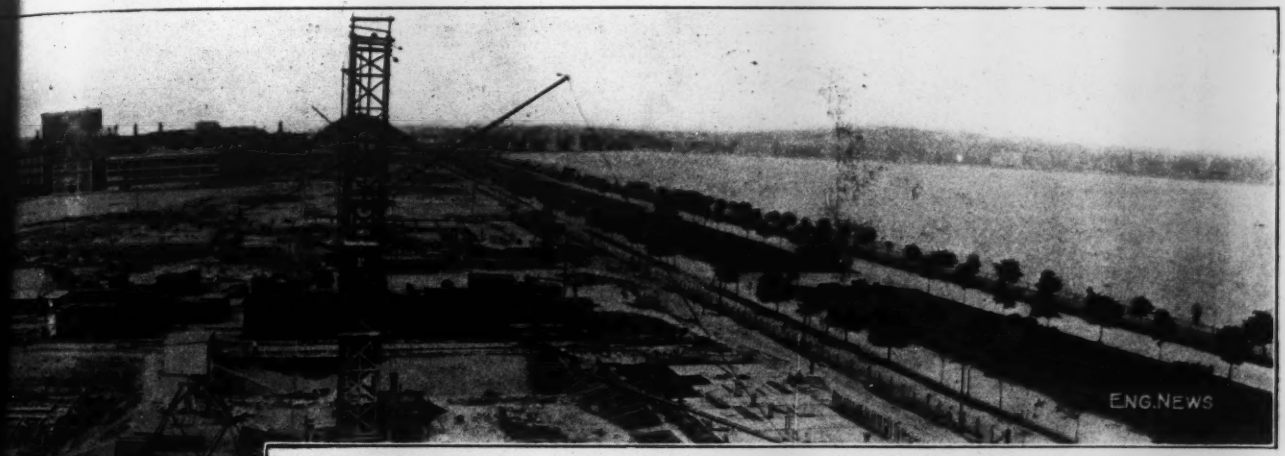
*For a description of the plans and layout see "Engineering News," Nov. 20, 1913, pp. 1053-55.

Further Studies of the Deodorizing Effects of Ozone

The published reports of Drs. E. O. Jordon and A. J. Carlson (See ENGINEERING NEWS, Nov. 27, 1913), which were unfavorable to the general use of ozone in ventilation and therapeutics, naturally raised a storm of criticism from more or less interested parties. Some of this was mere assertion, but there has been also the very desirable result of a careful scientific scrutiny of

the procedure of the investigators named. One of the most interesting and illuminating counter-investigations is that made by J. C. Olsen and W. H. Ulrich, of the Brooklyn Polytechnic Institute and reported in a paper at the Troy meeting of the American Institute of Chemical Engineers, June 19, 1914.

The original investigators (Jordon and Carlson) experimented with a considerable number of odorous substances and reached the broad conclusion that ozone masked but did not destroy odor. Their method of procedure consisted of exposing the substance, giving off odor until the smell was noticed in a small closed room. Then a commercial ozone generator was operated until a strong counter-odor was produced. Observations were made from time to time of the smell in the room and it was observed in many cases that the ozone odor gradually disappeared and that the odor of the peculiar substance under trial returned. In some cases the ozone was introduced again and the observations repeated.



MASSACHUSETTS INSTITUTE OF TECHNOLOGY

(Looking across the Charles River toward Boston to the eastward.)

Olsen and Ulrich criticized the earlier investigators for apparently neglecting to consider that any destruction to be found would be an oxidizing process and one in which a definite amount of oxygen would be required to oxidize a definite amount of odor substance, and for not knowing whether or not they had supplied sufficient ozone at any time to oxidize more than a fraction of the odor substance in the air. The counter-investigation was made to consider these factors.

They took up first hydrogen sulphide, 34 parts of which would require 48 parts of ozone for oxidation. They found, with 7.6 mg. of hydrogen sulphide liberated per cubic meter of room atmosphere, that no odor was noted and lead-acetate paper turned brown very slowly. A faint odor was detected with 15 mg., a distinct odor with 61, and a strong odor with 244. In comparison with this they found that the odor of ozone was marked when there was present only 1 mg. per cu.m., the limit of observation being 0.1 mg. A concentration of 1 mg. ozone would have masked the odor of 61 mg. hydrogen sulphide and by the action of the ozone less than 1 mg. of the 61 would be oxidized—leaving sufficient hydrogen sulphide unattacked to give the characteristic odor.

Atmospheres of hydrogen sulphide and ozone were combined with respective concentrations of 25 and 35.6 mg. per liter, under which conditions there should be just enough ozone to oxidize the hydrogen sulphide. The ozone odor was very pronounced at first, but after it had disappeared there was no odor of hydrogen sulphide. A slight acidity of the residual atmosphere was detected on exposure of blue litmus paper. Some oxidation was reported in check trials with atmospheric oxygen.

Observations were also made with ammonia; of this, one part would be oxidized by about four parts of ozone. With 10 mg. per cu.m. no characteristic odor was noted and no action was found upon litmus paper. With 21 mg. there was very faint odor and reaction; with 82 mg. the odor was quite distinct and the red litmus turned blue very slowly; with 329 mg. the odor was fairly strong and the litmus turned blue slowly; with 1000 mg. the odor was strong and reaction rapid. Atmospheres of ozone and ammonia were mixed in concentrations of 35.6 and 125 mg. per cu.m., respectively. As the action was slow, 24 hr. was allowed for it. Some oxidation was found, though not the destruction of the full 8.5 mg. theoretically expected. (Foreign investigators have reported finding no reaction between ammonia and ozone.)

Studies were made with oil of cloves. The amount of ozone necessary to oxidize the vapor of oil of cloves could not be calculated, but the investigators believed that it would require several times more than equal weight. It was found that as little as 66 mg. oil evaporated per cu.m. of atmosphere resulted in a strong smell. On mixing the oil-of-cloves atmosphere and ozone, with concentrations of 36.6 and 33 mg. per cu.m., respectively, it was found that first there was a distinct smell of ozone, but this gradually disappeared and was replaced by a sweet odor which had no resemblance to the original cloves. This was interpreted as meaning that the strong smelling constituents were partially oxidized. The reaction, however, was not entirely regular. The formation of the sweet aromatic residue was repeatedly observed, though at times the original odor of cloves persisted.

The First Large Ship Through the Panama Canal

The official opening of the Panama Canal to the commerce of the world took place Saturday, Aug. 15, with very little pomp or ceremony.

On Aug. 3, the "Cristobal," a 9600-ton steamship of the Panama R.R. Co., made the passage from the Atlantic to the Pacific in 11½ hr., and returning in 8½ hr.

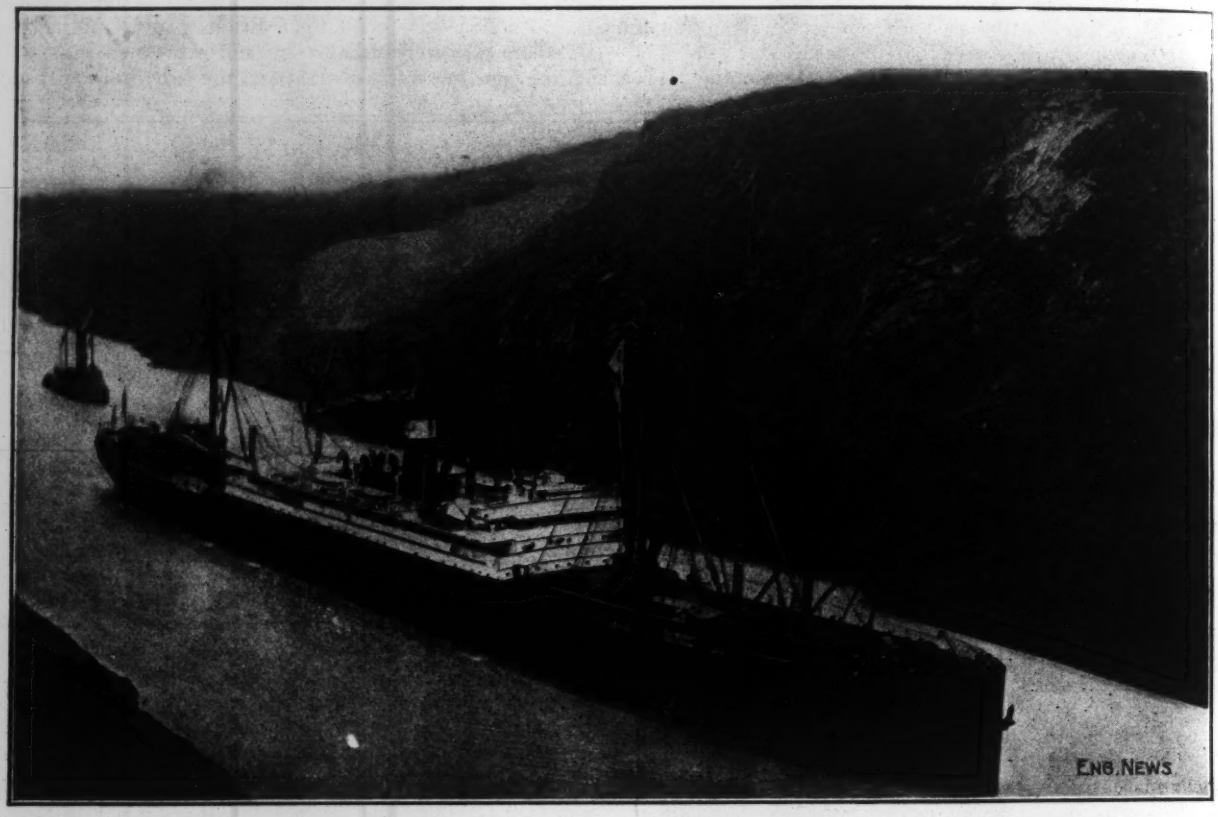
The "Cristobal" is a steel twin-screw steamship of 9606 gross tons and 6195 net tons burden. It is 489½ ft. long and 58 ft. in beam, drawing 25 ft. of water.

The passage was made without accident other than some minor difficulties with the towing locomotives.

NEWS NOTES

An Old Wooden Bridge Collapsed just after an automo had passed over it, at Pickering, Ont., on Aug. 6. The st ture was called Maxwell's Bridge. Its span is given 100 feet.

A 50-Hp. Boiler Exploded at a shop in Unicorn, Penn 10:30 p.m., Aug. 6. It was lifted from its brick setting hurled through a wall into a field across the road, a dista of about 130 ft. The crown sheet was thrown about 50 away. The brick stack and the rear of the shop w wrecked. Press reports state that the fire had been bank as usual that night, at which time the steam pressure w about 30 lb.



THE STEAMSHIP "CRISTOBAL" IN CULEBRA CUT, AUG. 3, 1914; 9600-TON STEAMER, 489½ FT. LONG, 56 FT. BEAM

Tugs, barges and dredges had been passed through the canal before, but this was the first large steamship.

On Aug. 15, the official party, including Col. George W. Goethals, Governor of the Canal Zone, and about 75 officers made the trip from the Atlantic to the Pacific in the "Ancon," of the Panama Railroad Co., a sister ship of the "Cristobal." The passage of the Gatun locks was made in 70 min., and the whole trip took 9 hr.

The Canal is now open to all vessels not drawing more than 30 ft. of water; this includes war vessels of the European nations now at war, but no warship of a belligerent power may remain longer than 24 hr. within the limits of the canal.

The principal work remaining to be done is the deepening and widening of the channel through Culebra cut.

A Gate Accident on the Welland Canal—An unusual accident occurred at Lock 12 of the Welland Canal, on Aug. 9, which stopped transportation for about 24 hours, according to the acting superintending engineer, St. Catherines, Ont. The steamer "Windsor," of the Montreal Transportation Co., upbound to Port Colborne for grain, had just entered the lock; one footgate had been closed and the other was about to be closed when the Canal helpers, who are hired by vessels navigating the Canal, opened wide the valves in the upper gates. The closing footgate was caught by the current and crashed against the closed gate, mitering with it imperfectly. This sudden closing caused a surge in the lock, which carried the vessel (full Canal size) against the headgates, unmitering them. The rush of water from Lock-12 reach carried these gates away and backed the steamer into the reach below, breaking the footgates. The canal banks at the head of Lock-11 were badly scoured. The ship was not damaged. Four gates were installed before traffic was resumed. The damages were estimated at $8000.

The Greater Winnipeg Water Supply project, for bringing water from Shoal Lake, 95 miles northwest of the city, is progressing. The entire right-of-way for the aqueduct, 85

miles has been cleared of timber and the work for its drainage is proceeding rapidly, while about 40 miles of grading has been done for the construction railway over the route and about 20 miles of track have been laid. Plans and specifications have been completed for the construction of 85 miles of the gravity-flow concrete aqueduct, which will extend from Indian Bay to the storage reservoir site southeast of Transcona, a few miles from Winnipeg. Pipe lines will run from this reservoir to the city. Bids for the aqueduct work will be opened Sept. 19. The total cost of the project is estimated at $13,000,000, and the construction work will occupy probably five years. The project is under the direction of the Greater Winnipeg Water District. S. H. Reynolds is Chairman of the Commissioners; W. G. Chase is Chief Engineer; James H. Fuertes, New York City, is Consulting Engineer. An outline of the project as recommended by a board of consulting engineers consisting of Rudolph Hering, Frederic P. Stearns and James H. Fuertes was printed in "Engineering News" of Sept. 25, 1913.

A Telephone Block System is to be installed by the Southern Ry. on the Atlantic Division, between Macon, Ga., and Ooltewah Junction, Tenn., 225 miles. The present telegraph block system consists of one telegraph wire. The telephone block is to consist of two wires, this arrangement being effected by utilizing the present telegraph block wire and a telegraph message circuit. Each office on this block circuit will be equipped with two bells, one for the north block and one for the south block, with the telephone so installed that it can be connected with either set. The lines will be so arranged at the offices that when a block office is closed the line can be cut through. The wires used for the telephone block will be used also for a telegraph circuit from Atlanta to Macon, and for another circuit from Atlanta to Ooltewah Jct., into Chattanooga, Tenn. In order to take care of the heavy Florida traffic last winter, the telephone block system was put in operation between Macon and Jesup, and was found so satisfactory that it has now been decided to extend the system. The management has also authorized the installation of a Simplex telephone block circuit between Monroe, Va., and Greensboro, N. C., 120 miles. The work is under the direction of W. H. Potter, Superintendent of Telegraph.

PERSONALS

Mr. R. C. Harris has been appointed Resident Engineer of the Alberta division of the Canadian Pacific Ry., at Calgary, Alta.

Mr. J. T. Brown has been appointed Resident Engineer and Superintendent of Bridges and Buildings of the Canadian Pacific Ry., Alberta division, at Cranbrook, B. C.

Mr. George Stahl has been appointed City Engineer of Milwaukee, Wis., succeeding Mr. J. A. Mesiroff, who resigned some time ago to become Consulting Engineer of the Western Engineering & Construction Co., of Milwaukee.

Mr. Donald F. McLeod, Assoc. M. Am. Soc. C. E., former City Engineer of Saranac Lake, N. Y., recently of New Glasgow, N. S., Canada, has been made City Manager of Lakeland, Fla.

Mr. A. G. Kinyon, formerly Locomotive Fuel Engineer of the Clinchfield Fuel Co., Spartansburg, S. C., has been appointed Superintendent of Locomotive Operation of the Seaboard Air Line Ry., with headquarters at Portsmouth, Va.

Mr. H. J. Saunders, Assoc. M. Am. Soc. C. E., formerly Consulting Engineer with offices at Valier, Mont., has been appointed Office Engineer, Division of Valuation, Interstate Commerce Commission, Western District, with headquarters at San Francisco, Calif.

Mr. Arnold Pfau, M. Am. Soc. M. E., Consulting Engineer of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., one of the foremost designers of hydraulic turbines, is being detained in Switzerland, where he went to visit his old home. Mr. Pfau is a native of Switzerland and is eligible for army service there.

Mr. W. E. Thomas, Assoc. M. Am. Soc. C. E., former Resident Engineer of the Flushing improvement of the Long Island R.R., New York City, is now District Manager at Charlotte, N. C., for Weston & Brooker, Inc., of Columbia, S. C., designers and builders of sanitary sewerage systems and sewage disposal works.

Mr. Frederic A. Delano, M. Am. Soc. C. E., whose appointment as a member of the Federal Reserve Board was noted in our columns of last week, has resigned as President of the Chicago, Indianapolis & Louisville Ry., to accept the appointment. He is to be Vice-Governor of the Board and will have headquarters at Washington, D. C.

Mr. R. W. Creuzbaur, M. Am. Soc. C. E., Consulting Engineer, New York City, has been appointed Engineer of the City of Elizabeth, N. J., to supervise the city's part in the grade-crossing elimination and improvement work of the Pennsylvania R.R. and Central R.R. of New Jersey in that city. Mr. Creuzbaur will devote only a portion of his time to this work.

Mr. King Lo, a resident of Canton, China, is studying highway work as an official representative of the Chinese Government in the main office of the New York State Highway Department, Albany, N. Y. Mr. Lo is a graduate of Rensselaer Polytechnic Institute. His education and practical experience are at the expense of the Home Department of the Chinese Republic.

Mr. Roger L. Morrison, Jun. Am. Soc. C. E., of the road department of the United Gas Improvement Co., of Philadelphia, Penn., has been appointed Professor of highway engineering at the Agricultural and Mechanical College of Texas, succeeding Mr. R. J. Potts, resigned, as noted in our personal columns of July 9. Mr. Morrison is a graduate of the University of Illinois, class of 1911, and of the Columbia University course in highway engineering.

Mr. E. J. McCaustland, M. Am. Soc. C. E., formerly Professor of municipal and highway engineering at the University of Washington, Seattle, Wash., President and Sanitary Engineer of the Washington State Board of Health, has been appointed Dean of the Faculty of Engineering at the University of Missouri, succeeding Mr. Howard B. Shaw, who has resigned to become Chief Engineer of the Missouri State Public Service Commission, as noted elsewhere.

Mr. Howard B. Shaw, Assoc. Am. Inst. E. E., formerly Professor of electrical engineering and Dean of the Faculty of Engineering at the University of Missouri, has been appointed Chief Engineer of the Missouri State Public Service Commission. Mr. Shaw is a graduate in civil engineering of the University of North Carolina, class of 1890, and received the degree of A. M. at Harvard University in 1894. For two years, he was an Assistant in the electrical engineering laboratory of the Lawrence Scientific School, Harvard University, and since 1896 he has been connected with the faculty of the University of Missouri.

Mr. George W. Boschke, who resigned as Chief Engineer of the Oregon-Washington R.R. & Navigation Co. on May 1, has been appointed Engineer in charge of the San Francisco, Calif., offices of Twohy Bros., of Portland, Ore., railway contractors. Mr. Boschke began his railway engineering experience in 1886 with the Southern Pacific Co. He had charge of the construction of various lines in Texas, and in addition to his connection with the Southern Pacific Co., was Engineer in charge of construction of the Galveston, Tex., seawall. He was Chief Engineer of the Oregon-Washington R.R. & Navigation Co. from 1905 until May 1, 1914.

Mr. David B. Steinman, Jun. Am. Soc. C. E., former Professor of civil engineering at the University of Idaho, has been appointed Special Assistant Engineer of the New York Connecting R.R. Hell Gate Bridge, New York City, to temporarily succeed Mr. O. H. Ammann, M. Am. Soc. C. E., who has returned to his native country of Switzerland to serve in the army, as noted in our issue of last week. Mr. Steinman is a graduate in civil engineering of Columbia University, class of 1909, and received a Ph. D. degree there in 1911. For a short time he was connected with engineering staffs of the Board of Water Supply and the Public Service Commission in New York City, and since 1910 has been Professor of civil engineering at the University of Idaho.

Col. Merritt H. Smith, M. Am. Soc. C. E., whose appointment as Chief Engineer of the Department of Water Supply, Gas and Electricity was noted in our personal columns of July 9, was the guest of honor of 700 enthusiastic engineer and contractor friends at a dinner at the Biltmore Hotel, New York City, Aug. 13. Although the weather was unusually hot, the hotel accommodations were taxed to the utmost. The guests included Mayor John Purroy Mitchel, all three members of the Board of Water Supply, the Borough President of Manhattan, and other prominent city officers. Mr. J. Waldo Smith, Chief Engineer of the Board of Water Supply, was toastmaster. Many old-time members of the Board of Water Supply engineering staff, now prominent in the public works of other cities, journeyed to New York to attend; and the meeting was more of the nature of a college alumni feast than anything else. Col. Smith has been one of the most popular members of the engineering corps of the Board of Water Supply, and has done much to inspire the feeling of good fellowship and the esprit de corps for which this engineering staff has been famous.

OBITUARY

John P. Holland, famous as the inventor of the Holland submarine boat, died at his home in Newark, N. J., Aug. 12. He was born in Paterson, N. J., 73 years ago. His first submarine boat was built in 1875 and launched in the Passaic River in 1878.

Charles T. Healy, a well known land surveyor and civil engineer, of Los Angeles, Calif., died at his home in that city Aug. 3, aged 85 years. He went to California in the pioneer days, 60 years ago, and for many years was engaged in land surveying and civil engineering. He is said to have surveyed many of the original plots in Los Angeles and Long Beach.

Joseph J. Cox, a prominent Kansas contractor, died Aug. 4 at his home in Lawrence, Kan., after an illness of more than six months. He was born in Seymour, Ind., Oct. 6, 1853. In 1870 he moved with his parents to a farm near Lawrence, Kan., where he was married in 1872. Subsequently he went into contracting and during the long course of his business life completed many important structures.

Charles Webster Danforth, New York Manager of the Pittsburgh Steel & Iron Co., Pittsburgh, Penn., died Aug. 9, in the Grand Central Station, New York City, while about to start on a vacation. He was born in New Haven, Conn., and was a graduate of Sheffield Scientific School, Yale University, class of 1896, in civil engineering. He was formerly with the American Bridge Co., of Pittsburgh.

Donald M. Philbin, recently General Manager of the Great Northern ore properties in Minnesota and formerly General Superintendent of the Lake District of the Great Northern Ry., died Aug. 6, at his home in Duluth, Minn., after an illness of over a year. He was born in Montreal, Que., in 1857, and at 17 years of age began his railway experience as a clerk in the construction department of the Chicago & Northwestern Ry. From 1877 to 1886 he was in charge of the ore docks of the Chicago & Northwestern Ry. at Escanaba, Mich., and for two years in charge of the ore docks of the Milwaukee, Lake Shore & Western R.R. at Ashland, Wis. In 1890 he was appointed Division Superintendent of the Duluth, South Shore & Atlantic Ry., and from 1893 to 1896 was General Manager of the Duluth, Missabe & Northern Ry. Subsequently he was an operating officer of lines which became a part of the Great Northern Ry.

Edward C. Johnson, recently Commissioner of Public Works, of Los Angeles, Calif., died Aug. 3, at his old home in Belfast, Maine. He was a graduate of the Massachusetts Institute of Technology, and for several years was on United States Government Survey work in the West. He first came into public notice in Los Angeles during the investigation of the Los Angeles Aqueduct, when he was appointed a member of the investigating committee as an engineering expert. Following his work here he was appointed a member of the Harbor Commission, and upon the resignation of Gen. Adna R. Chaffee from the Board of Public Works, a few years ago, Mr. Johnson was appointed to succeed him, and as such had charge of the aqueduct work. For the last eight months he had been in failing health, and some weeks ago returned to his home in Maine, and resigned his office in Los Angeles shortly afterward. Mr. Johnson is survived by a widow and a daughter eight years old.

Alfred P. Trautwein, M. Am. Soc. M. E., Vice-President of the American Welding Co., Carbondale, Penn., died Aug. 5. at his home in Scranton, Penn. He was born in New York City in 1857 and graduated in mechanical engineering at Stevens Institute of Technology in 1876. He went to Carbondale in 1889 as Consulting Engineer of the Hendrick Manufacturing Co. Later he organized and was President of the Carbondale Machine Co. He also aided in organizing the Carbondale Chemical Co., the Carbondale Instrument Co., the American Welding Co., and numerous other enterprises. He was a member of the Engineers' Club of Philadelphia, and a Past-President of the Scranton Engineers' Club. He was also a Past-President of the Engineering Society of Northeastern Pennsylvania. Mr. Trautwein was a trustee of Stevens Institute and a director and trustee of many other business, educational and philanthropic institutions. He is survived by a widow and four daughters.

Henry L. Oestreich, M. Am. Soc. C. E., Senior Assistant Division Engineer, Public Service Commission, First District, New York, died Aug. 13, at Atlantic City, N. J., aged 45 years. He was born in New York City and attended the public schools and New York University. He joined the engineering staff of the old Rapid Transit Commission as Assistant Engineer at the beginning of the New York City subway work in 1900, and ever since then continued in the employ of the city. He had charge of construction of the section of the present subways on Lafayette St. and 4th Ave., between Great Jones and 19th St. Later he had charge of important construction on the Centre St. loop. Recently he had been in charge of sections of the Fourth Ave. subway in Brooklyn. Mr. Oestreich was married on June 10, 1914, to Miss Stella B. Eccles, of Trenton, N. J., and went to Atlantic City on his honeymoon. While there he contracted blood poisoning from a scratch on his face. He was a prominent member of the Brooklyn Engineers' Club and of the Municipal Engineers of the City of New York.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 20-21. Annual meeting in New York City. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN PEAT SOCIETY.
Aug. 20-22. Annual meeting at Duluth, Minn. Secy., Julius Bordollo, 17 Battery Place, New York City.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Sept. 1-4. Annual convention in New York City. Secy., J. D. Farasey, E. 37th St., and Erie Ry., Cleveland, Ohio.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 7-10. Annual meeting in New York City. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 7-11. Annual meeting at Chicago, Ill. Secy., A. P. Backert, Cleveland, Ohio.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.
Sept. 9-11. Annual convention at Buffalo, N. Y. Secy., Will P. Blair, 832 B. of L. E. building, Cleveland, Ohio.

NATIONAL ASSOCIATION OF PORT AUTHORITIES.
Sept. 8-10. Annual convention in Baltimore, Md. Secy., Wm. Joshua Barney, 29 Broadway, New York City.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 8-11. Annual meeting at Chicago, Ill. Secy., L. C. Ryan, Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 8-11. Annual convention in Nashville, Tenn. Secy., A. P. Dane, Reading, Mass.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 9-11. Annual convention in Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 15-18. Convention in Atlantic City, N. J. Secy., Clayton W. Pike, Electrical Bureau, Philadelphia, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

ATLANTIC DEEPER WATERWAYS ASSOCIATION.
Sept. 22-26. Annual convention at New York. Secy., Addison Burke, Philadelphia, Penn.

American Boiler Manufacturers' Association—The 26th annual convention will open at 10 a.m., Sept. 1, at the Waldorf-Astoria Hotel, and close with an executive session Friday morning, Sept. 4. There will be four business sessions and probably a trip to Coney Island Wednesday evening. The annual banquet will be held at 7:30 p.m., Sept. 3. The secretary is J. D. Farasey, East 37th St. and Erie Ry., Cleveland, Ohio.

Illuminating Engineering Society—Among the papers to be presented at the annual meeting in Cleveland, Ohio, Sept. 21-26, are the following: "Factory Lighting," Hogne and Dicker; "Planning for Daylight and Sunlight in Buildings," Marks and Woodwell. "The Effects of Room Dimensions on Efficiency of Lighting System," Ward Harrison; "Illumination of Light Shafts," S. H. Sharp; "The Locomotive Headlight," J. L. Minick; "Physiological Effect of Light on the Body," E. C. Titus.

American Foundrymen's Association—At the annual meeting to be held Sept. 7-11, at Chicago, the following papers will be presented: "The Second-Story Foundry," G. K. Hooper, Detroit; "Molding Sand Tests," Dr. Richard Moldenke, Watchung, N. J.; "Test of Malleable Cast Iron," Enrique Touceda, Albany, N. Y.; "The Electric Furnace in the Steel Foundry," W. L. Morrison, Welland, Ont.; "Some Defects in Steel Castings and Remedies for Them," John Howe Hall. The Secretary is A. P. Backert, Cleveland, Ohio.

Engineering Literature

CONTENTS

Page

CORRESPONDENCE:
Continuation of Title-Page Date Discussion. Wm. A. Del Mar 419

REVIEWS AND NOTES:
The Microscopy of Drinking Water. Reviewed by Desmond FitzGerald 420
Mechanics and Heat 420
A Glossary of Road Terms 420
Metallurgy of Copper. Reviewed by F. W. Traphagen 421
Field Manual for Plane Surveying and Railroad Curves 421
Power and Power Transmission 421
Influence Diagrams 421
Motorcycles, Side Cars and Cycle Cars—Location of Motorcycle Power-Plant Troubles Made Easy 421
Oil Production Methods 422
Symmetrical Masonry Arches 422
Molded Electrical Insulation and Plastics 423
The Steel Foundry. Reviewed by William R. Conrad 423
PUBLICATIONS RECEIVED 424

CORRESPONDENCE

Continuation of Title-Page Date Discussion

Sir—I have read with interest Dr. C. T. Hutchinson's letter published in your issue of July 16, in which he denounces the use of the term "Second Edition Revised" to designate the current issue of my book on "Electric Power Conductors."

The book under consideration has 324 pages, exclusive of the index. In anticipation of the exhaustion of the first edition, 14 new pages of electrotype were made and 29 pages had their electrotype altered or corrected, a total of 43 pages, or 13⅓% of the entire number of pages in the book. This percentage reduces to 12 if the 4-page rubber specification is omitted. I said in the preface that "nearly 10%" of the pages had been more or less altered. It will thus be observed that I understated the proportion rather than overstated it as intimated by Dr. Hutchinson. Nevertheless, I do not think that the minor alterations would have justified calling the book a second edition, but I do believe that the changes on about 20 of the pages were ample warrant for doing so. The book, altered as described above, was issued as a second edition at the suggestion of the publisher and with my approval. There was ample respectable precedent for this action and none that I know for any other course.

If the book had been sold as a reprint of the first edition, a great deal of confusion would have resulted in making references. For example, if an engineer were to order wire insulated in accordance with the specification in the first edition of "Electric Power Conductors," and if both editions were known as first editions, the manufacturer would be at a loss to know what to supply, and the purchaser would not be sure of getting what he wanted.

I am in sympathy with Dr. Hutchinson in deploring the uncertainty incident upon the use of the word "edition." The whole trouble is that the word "edition," and its various qualifying terms, do not mean the same thing to different people. Thus, it is evident that to Dr. Hutchinson, the term "Second Edition Revised" means what the publishers usually call "Entirely Rewritten."

I believe that Dr. Hutchinson could have employed his talent to better advantage if he had taken the trouble to write a constructive letter suggesting a series of terms to describe the different varieties of revisions of a book. If such a letter had been written and followed up by an effort to have its recommendations adopted by the publishers as standard, Dr. Hutchinson would have rendered a distinct service.

WM. A. DEL MAR.

70 East 45th St., New York City, July 30, 1914.

REVIEWS AND NOTES

A New Edition of Whipple's Microscopy of Drinking Water

REVIEWED BY DESMOND FITZGERALD*

THE MICROSCOPY OF DRINKING WATER—By George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering, Harvard University and the Massachusetts Institute of Technology. With a Chapter on "The Use of the Microscope," by John W. M. Bunker. Third edition, rewritten and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xxi + 409; 73 illustrations; 25 plates. $4, net.

More than one water-works engineer will figuratively toss his hat into the air and shout "Hurrah!" at the appearance of a third edition of Whipple's book; firstly, because the book has proved itself already of real practical assistance in water-supply practice; and secondly, because this new edition is a demonstration of the popularity of a good scientific treatise on the microscopy of drinking water; in fact, the day is fast approaching when no manager of a water-supply system can afford to be without it, and the day is already here when libraries which are looking around for standard treatises, welcome it to their shelves.

In addition to pointing out the connection between odors and tastes in water and the life histories of its organisms, Prof. Whipple tells us all about different methods of treatment to cure the troubles that attack water-supplies.

The new edition is a book of about the same size as the previous edition, but a brief examination shows that it contains a considerable amount of new material, to keep abreast with the times. There has been a slight rearrangement, by which the space formerly given to bibliog-

*Consulting Engineer, Brookline, Mass.

raphy is reduced, and 86 more pages of printed matter added. The plates are now slightly colored as once suggested by ENGINEERING NEWS.

The book is divided into two parts; part one discussing sanitary problems, and part two dealing with a more technical classification of microscopical organisms. The first part has been expanded from thirteen to eighteeen chapters, in order to embrace a fuller discussion of different treatments of water-supplies. The question of stripping of reservoir sites is discussed and the use of the microscope is made easier by a special chapter, written by an expert, Dr. John W. N. Bunker.

There is nothing left to be desired at the present time in any of the chapters which deal with the collection of samples, methods of examination, linnology, and seasonal distribution of organisms.

In regard to soil stripping, the reviewer thinks that not enough attention has been paid in the public discussions of the subject to the importance of discriminating more fully in the local conditions as regards the desirability of stripping the sites of reservoirs. Even in very large reservoirs, he believes it will eventually be found advantageous to carry out certain modifications of the principles of shallow-flowage treatment and stripping; such, for instance, as were applied to Basins 2 and 3 of the Boston Water-Works System in 1881, 1882 and 1883. There, for a comparatively small expenditure, thousands of stumps were removed which were found to be in a particularly offensive condition of change, shallow-flowage places were filled with loam and mud, removed from adjacent areas, and a better quality of water secured.

The Hopkinton and the Sudbury basins were the only ones of the Boston system where all organic matter was removed from the bottom and sides of the reservoirs and the shallow places filled. In small supplies and small reservoirs, where the incoming water has but little time for improvement by storage, it is especially desirable to consider shallow-flowage treatment and at least partial stripping, and under some conditions, it is desirable to treat the reservoirs to a certain extent even if filtration is to be added. Owing to the fact of the enormous differences existing in local conditions the services of a competent expert are generally required.

All water-works engineers will welcome the chapters on aëration, growth of organisms in water pipes, and the fine plates and classifications of algae and other growths. Prof. Whipple has done a good life's work already in popularizing the use of the microscope in the solution of important sanitary problems connected with public and private water-supplies. It now only remains for him to show in detail how a large water-supply system like that of the Metropolitan District of Boston is guided almost daily by the studies in its laboratory of the condition of the various reservoirs and the life of the organisms, and how that information is made available in the practical management of the supply.

The Illinois Steel Co., Chicago, Ill., is rolling six specially slender I-beam sections, which have greater moment of inertia in proportion to the weight than standard I-beams. A little book just issued lists them, and also gives a table covering the standard I-beams. The new shapes are 24, 21, 18, 15, 12 and 10 in. deep, and range 9 to 3 lb. lighter than the minimum standard section. The addition of a 21-in. section in place of the usual 24-in. I-beam makes the progression of depth more uniform.

These shapes are naturally intended mainly for application in buildings where web thickness and provision of extra thickness against rusting are not usual factors.

Physics for Engineering Students

MECHANICS AND HEAT—By William Ballantyne Anderson, Associate Professor of Physics, Iowa State College. New York and London: McGraw-Hill Book Co., Inc. ["Physics for Technical Students."] Cloth; 6x9 in.; pp. xi + 316; 153 text illustrations. $2, net.

Prof. Anderson here presents the classic elements of physics, though only partially by strictly classical methods of teaching. The volume may be called "elementary" in the sense that it is adapted to first classes of collegiate grade, though it is too advanced a text by which to introduce the subject to a young student for the first time.

The application of natural laws is made real by practical applications at every turn, though the book is not of the "natural-philosophy" variety so much in favor at the present for teaching rudimentary physics. The author, however, does not use the inductive method of reasoning from observed particular phenomena to general laws, but seems to prefer that familiar scheme, which multitudes of teachers are breaking away from, of giving definitions, broad statements and, finally, applications. The author voices the familiar complaint that engineering students lack grasp of fundamental principles of physics; but he does not strike at the root of the evil—the failure of the much tried deductive methods of teaching science to approximate natural mental processes in the investigative mind. The need for improved equipment of engineering students is seen, but the author aims to secure it by overhauling old practices and appending practical application and problems. That makes this teaching text better than some older ones by just as much as it departs from them. It can probably be used with marked success on students who have some previous knowledge of natural phenomena and general laws gained by inductive processes of instruction. But the greatest attainable success, it would seem, is to be secured by pursuing to the limit the procession from particular facts to general laws, for that is what every engineering investigator must do in after life. This text is not in harmony with such a plan.

The book starts with fundamental dimensions and measurements and presents vector quantities; it discusses rectilinear and rotary motions, leading up to general concepts of force, energy and power. Then elementary machines are presented at the end of Part I. Part II concerns itself with the properties of matter—at rest and in motion; Part III includes thermometry, calorimetry, general heat phenomena, meteorology and heat engines.

A GLOSSARY OF ROAD TERMS—By H. Percy Boulnois, M. Inst. C. E., Borough Engineer of Portsmouth; City Engineer of Liverpool; Deputy Chief Engineer Inspector of the Local Government Board. London: St. Bride's Press, Ltd. Cloth; 5x8 in.; pp. 71. Two shillings, net.

Readers of British engineering journals are often puzzled as to the meaning of some of the technical terms used. For instance, "boning" is leveling by eye with cross-heads called "boning rods"; "kerb" is a curb; a "buddle-hole" is a gulley constructed partly under a "kerb"; a "cesspit" is a "gulley pit," or "catch pit," or in plain American, a catchbasin. There are numerous

other British terms, which we believe the average American reader would need to have defined, if the context did not generally show what our English cousins were writing about. Hence this little book may be of real service to American readers of English highway literature.

A Compendium of Copper Metallurgy

REVIEWED BY PROF. F. W. TRAPHAGEN*

METALLURGY OF COPPER—By H. O. Hofman, Professor of Metallurgy, Massachusetts Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 556; 548 illustrations. $5, net.

This second volume in Hofman's new metallurgical series is maintaining the high standard of the first number on "General Metallurgy."

The author has given a very complete review of the subject and the work will serve many metallurgists as a handy compendium on the subject. Matters are discussed in very great detail and the illustrations, in many cases dimensioned, could be used as working drawings. Much valuable information is condensed in the numerous tables.

The more important chapters are those on smelting and on leaching of copper ores and on electrolysis. In attempting to present an exhaustive treatise in which he has fairly succeeded, the author has been compelled to discuss many devices and practices which in some cases are obsolete and in others used only under exceptional conditions.

The experienced metallurgist will be but little embarrassed by this, but the reader of little experience in the metallurgy of copper may have much difficulty in sifting the wheat from the chaff.

One excellent feature introduced in this series is the constant reference to original authority for every important statement. This gives very great value to the work and enables readers to follow up in detail any particular matters in which they may have especial interest.

Numerous typographical errors mar the work. These will, of course, be removed in a second edition, which will be certain to be called for. It is understood that an edition in German is already arranged for and we look for editions in other languages, for the book is especially complete and uptodate.

A final report of the "Committee on Runoff from Sewered Areas," appointed May 1, 1907, by the Sanitary Section of the Boston Society of Civil Engineers, appears in the *Journal* of the Society named for June, 1914. The report describes a number of rain gages and automatic sewage-flow recorders, giving the price of each one available. It also contains text and tables giving the results of rainfall and runoff studies in various cities. There is a bibliography. The report occupies 90 pages. The Committee included George A. Carpenter, City Engineer of Pawtucket, R. I., as Chairman; Harrison P. Eddy, Consulting Engineer, 14 Beacon St., Boston, Mass., as Secretary and six other members.

A paper entitled "Mechanical Treatment of Sewage in Germany," translated from a German article by Dipl.-Ing. Endris, Engineer with the City of Hamburg, Germany, and author of numerous papers on the art of sewage treatment, forms the major portion of a bulletin issued by the Sanitation Corporation, 50 Church St., New York City, bearing the date of May, 1914. Aside from some introductory matter, the paper is devoted almost wholly to the evolution and present design and uses of the Riensch-Wurl screen. This screen has been quite extensively used in Germany, and the company named above proposes to introduce it in the United States.

FIELD MANUAL FOR PLANE SURVEYING AND RAILROAD CURVES—By R. C. Yeoman, Dean of Engineering, Professor of Civil Engineering, Valparaiso University; City Engineer of Valparaiso, and E. A. Tucker, Instructor in Surveying; Assistant in Civil Engineering, Valparaiso University. Valparaiso, Ind.: M. E. Bogarte Book Co. Cloth; 5x8 in. $2.

The new idea in this book is its arrangement and purpose. It is intended to take the place of a text on surveying and to be the field supplement of lectures and assigned reading in standard texts. The size and make up of the pages are similar to a standard field notebook. First comes a double page with sample notes and sketch of an ordinary surveying problem or exercise, then two blank pages for the student to duplicate the problem, or one similar. In this manner the book is divided into seven groups of problems; pacing problems, chaining problems, leveling problems, compass and sextant, transit problems, astronomical surveying and railroad curves. Altogether there are 44 exercises.

There is no criticism of the book, but one may well question the expediency of teaching surveying in this manner. Is it better to tell a young man what you want done and leave it to his initiative and ingenuity to devise the best ways and means, with the help of necessary textbooks and verbal instructions, or to give him a cut-and-dried problem and say, go thou and do likewise? To help train a real engineer we would prefer the former.

POWER AND POWER TRANSMISSION—By E. W. Kerr, Professor of Mechanical Engineering, Louisiana State University. Third edition, thoroughly revised. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xii+391; 325 illustrations. $2, net.

The changes seen between this, the third, and the previous edition (see these pages for May 14, 1908), are in the nature of making the book uptodate—since it has been widely known as an acceptable teaching text for such technical students (like chemists and some civil engineers) as did not plunge deeply into mechanical engineering, but still required some knowledge of power applications. Some of the changes in illustration evidently have been made to improve the appearance of the pages in the reader's eye.

The most marked peculiarity of this useful compilation of scattered information is its continued silence about electric motors and generators—undoubtedly the simplest and most efficient devices of power transmission. A treatise is not needed on them but something is required for convenience in using this book in class.

INFLUENCE DIAGRAMS for the Determination of Maximum Moments in Trusses and Beams—By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vii + 65; 42 text figures. $1.25, net.

By systematizing the process of plotting the influence line for any member of a plane truss or frame subjected to moving load, Prof. Howe does a service of great value, particularly to those who—now and in the future—are studying the subject of trusses. The book is written

*Professor of Metallurgy and Assaying, Colorado School of Mines, Golden, Colo.

in a clear, short style, which makes it easy to read and understand, and it gives us that unusual phenomenon, a small book.

While bridge engineers at present have a clear idea of the meaning of influence line, they do not make very extensive use of these lines. A simple mechanical rule, by which an influence line can be sketched or drawn in a moment, without analytical study of the frame, is sure to make their use more common. This book should therefore find a large circle of readers and users. The fact that it develops the subject far enough to cover swing spans, arches, etc., makes it worth the study even of the experienced bridge engineer.

⁂

A Motorcycle Book and Chart

MOTORCYCLES, SIDE CARS AND CYCLE CARS: A Comprehensive, Nontechnical Treatise, Defining All Forms of the Lighter, Self-Propelled Vehicles, Principles of Operation, Construction and Practical Application of Components in Leading American and Foreign Machines—By Victor W. Page, author of "The Modern Gasoline Automobile," "The Modern Gas Tractor," "Automobile Questions and Answers," etc. New York: Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 550; 340 illustrations. $1.50.

LOCATION OF MOTORCYCLE POWER-PLANT TROUBLES MADE EASY—A Complete Chart Outlining the Common Derangements that Interfere with Proper Action of Engine and Auxiliary Systems, Arranged by Victor W. Page, author of "Motorcycles, Side Cars and Cycle Cars," etc. New York: The Norman W. Henley Publishing Co. Heavy Paper. Sent prepaid to any address on receipt of 25c.

Two previous books by this author on the modern gasoline automobile and on questions and answers relating to automobile design were reviewed in these columns on Feb. 13, 1913, and Jan. 15, 1914. The present book is similar in style to the previous volumes but deals exclusively with motorcycles and their recent development into what are known as cycle cars. The book is somewhat more elementary in its treatment than the books relating to automobile work above referred to, but like them is deserving of high commendation for the thoroughness and carefulness of the treatment given to the subject.

This book should prove a useful aid to the numerous engineers who own and use motor bicycles. It is doubtful, however, whether the cycle car will have any such large use in this country as it has secured in France and England. The very low price at which a regular automobile can be procured in this country makes it difficult for the cycle-car manufacturers to compete with them. Further than this, the cycle-car vehicles generally have a much narrower width of track than the standard. The difficulty of running such a vehicle with safety on rough country roads is evident enough; and it is in this locality that the demand for light, cheap cars is greatest. On the other hand, it is probably true that the designer of standard automobiles could learn much from a thorough study of cycle-car practice. There is yet to be produced a motor vehicle which can be driven over any rough country that can be traveled by a horse and buggy and which can be held down to the steady slow speed that is necessary to safely cross rough bits of road without undue strains on the vehicle and its occupants.

The chart for diagnosing motorcycle troubles should properly be regarded as a supplement to the book as it will be mainly useful to the cyclist who is already fairly familiar with the construction and operation of his machine.

⁂

C. W. Schubert, 1357 E. 110th St., Cleveland, Ohio, brings out a beam-designing chart of the familiar parallel-scale variety, which is printed on a matt-surfaced celluloid. The chart can be used by drawing pencil lines across the scales instead of merely laying a ruling edge across, and in this way is considerably more useful or convenient than a chart without this feature. The scales are arranged for both steel and wooden beams; in the case of steel beams they indicate the depth and section directly.

⁂

OIL PRODUCTION METHODS—By Paul M. Paine, Assistant Superintendent, Honolulu Cons. Oil Co., and B. K. Stroud, Petroleum Engineer; formerly Superintendent, Monte Cristo Oil & Dev Co.; Field Superintendent, Universal Oil Co., With a Chapter on Accounting Systems by W. F. and W. B. Sampson, Expert Accountants with Klink, Bean & Co. San Francisco, Calif: Western Engineering Publishing Co. Cloth; 6x9 in.; pp. 240; 216 text illustrations. $3, postpaid.

According to the preface this book has been prepared in response to a demand for a work describing, in a manner that may be understood by the layman, how oil wells are drilled and oil produced. The first two chapters are of general interest, describing the distribution, properties and uses of petroleum and the geological conditions under which it is found. The next two chapters describe drilling equipments and methods, and are of interest to those who have to make drill holes for other purposes as well. The fifth chapter covers the exclusion of water from oil sands, and the other three chapters describe the operation of the wells, handling of the crude oil and an accounting system for the business-like conduct of oil-well operation.

⁂

SYMMETRICAL MASONRY ARCHES, Including Natural Stone, Plain-Concrete and Reinforced-Concrete Arches. For the Use of Technical Schools, Engineers and Computers in Designing Arches According to the Elastic Theory—By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 241; 35 illustrations and 6 folding drawings. $2.50, net.

Some important additions make this second edition a distinct modernization. However, the favorable comments by Prof. Wm. Cain, in reviewing the first edition in our issue of Nov. 15, 1906, give as good a characterization of the book now as then. The tables of arches have been supplemented by a table giving arches built within the last ten years. The arch-coefficient method presented by the author in ENGINEERING NEWS, of June 2, 1910, forms the 40-page Appendix B; its tables of coefficients will be found of much use. Formulas for unsymmetrical arches are grouped in another appendix, thus serving the occasional need where symmetry cannot be maintained.

The author says that most of the text has been rewritten.

⁂

Our attention has been called to an error in the heading to the brief notice of J. J. Cosgrave's "Rock Excavating and Blasting" printed in our issue of May 21. The book was published by the author and not by the National Fire-Proofing Co., of Pittsburgh, as stated in the review. The material composing the book, however, first appeared in serial form in a magazine entitled "Building Progress," published by the company named. Mr. Cosgrove may be addressed at 215 W. Pomona St., Philadelphia, Pa.

⁂

PROCEEDINGS OF NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING—Held at Chicago February 12, 13, 14, 1914. J. P. Beck, Secretary, 208 South La Salle St., Chicago. Paper; 6x9 in.; pp. 210.

At the closing session of the National Conference on Concrete Road Construction, held at Chicago last Febru-

ary, it was voted that the full proceedings of the conference should be published. There were presented at that conference the reports of 15 committees, each of which dealt with some especial feature of concrete road work. Each of these committee reports received more or less discussion. There were also half a dozen papers and addresses. All this matter has just been issued in a well printed and well bound volume, which will doubtless receive the careful study of every engineer in any way interested in the subject of the conference. The volume opens with several pages on recommended practice in concrete road building, which were adopted by the conference, as reported by the Committee on Resolutions.

Electrical Insulations

MOLDED ELECTRICAL INSULATION AND PLASTICS—By Emilie Hemming. New York: Ward Clausen Co. Cloth; 5x8 in.; pp. 207; 36 plates and text figures. $3.

Mr. Hemming has succeeded in producing that modern rarity in technical literature, an entirely new book. The literature of electrical engineering, chemistry, ceramics, etc., has scattered through it, of course, a large amount of material relating to modern insulating materials, especially those of the plastic varieties, but so far as we are aware, all the information available on these products has remained scattered until this attempt to present it between the lids of one volume.

The author describes the advances which have been made, particularly in late years, in molded insulations for all sorts of electrical service, and then classifies the products of the present day under nine heads—organic hot-molded, organic cold-molded, inorganic cold-molded, ceramics, rubber compounds, organic plastics, synthetic resins, hardened fibers, molded mica. Before discussing the several classes in further detail, some forty-five pages are devoted to a description of the raw materials which enter into all of these various classes. This description includes the fundamental chemical elements, mechanical properties, etc., of a great variety of materials—asbestos, clay, mica, silica compounds, cement, earths, resins, vegetable fibers, mineral waxes, oils, solvents, rubber, and chemicals such as phenol, formaldehyde, etc.

Then follow details of making and using the classes of materials. All this material is reduced to its simplest and briefest form and should be understood without especially deep knowledge of chemistry, electricity or even of manufacturing processes. In the first group ("Class A, hot-molded organics") is discussed the use of shellac binders (or substitutes) with wood pulp, magnesia, lime, sand and asbestos. In the second group ("Class B, cold-molded organics"), the materials employed are much the same, but solvents take the place of heat in obtaining fluidity. The third group ("Class C, cold-molded inorganics") uses compounds of silica, alumina, lime and magnesia, or hydraulic cements with the same inorganic fillers named. "Class D" covers ceramics; "Class E," rubber compounds; "Class F" organic plastics—celluloid and casein; "Class G," the synthetic resins resulting from the reaction between phenol and formaldehyde; "Class H," vulcanized fiber; and "Class I," mica imbedded in binders.

The physical properties of completed articles are reviewed—life, ease of working, dielectric strength, mechanical strength, resistance to weather and heat, chemical inertness and appearance. Here is restated, under these respective heads, what is related before in discussing the several materials.

There is a long section on the limitations of molding and the attention that has to be given to good design of dies. Some 18 full-page plates illustrate various articles molded from these several varieties of material; accompanying page texts describe their use and note reasons for using the particular materials shown. Finally the results of some definite electrical, mechanical and thermal tests are shown.

How to Cast Steel

THE STEEL FOUNDRY—By John Howe Hall, Consulting Engineer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. ix + 271; 37 text illustrations. $3, net.

REVIEWED BY WM. R. CONARD*

The author gives a comprehensive description of the various processes of steel founding.

As a book for use in our institutions of learning, it should be of value to both the teacher and the student.

Again, it is of value to the man who is a consumer of steel in that it describes plainly the results obtained by the various processes and the advantages and disadvantages of each process.

It is particularly valuable to anyone entering this branch of industry or investing money in this line in that it gives in addition to the various processes, well considered estimates of costs and similar data which the layman might not know how to figure out. And in the last place, it is of especial value to the man who is actively engaged in the steel business as it brings all of the various methods under one cover, describing them all. The author has apparently endeavored to cover all phases of the industry from the factors which enter into the choice and cost of a given process to the laboratory where the results of the processes are analyzed.

PUBLIC ROADS AND HIGHWAYS COMMISSION OF ONTARIO—Report of 1914. Toronto: Office, Commissioners of Public Roads. Cloth; 7x10 in.; pp. 277; illustrated, and accompanied by six folding maps.

In addition to the regulation highway-commission report, this book is of interest because it contains a compendium of highway organizations in Canada and the United States. There is also a very interesting historical sketch of road development in Ontario. The most important part of the report is perhaps a study of the relation of farm values and agricultural improvement to highway improvement in the Province of Ontario.

A short, popular, but useful and forceful account of the "Salem Conflagration" (Salem, Mass., June 25 and 26, 1914) has been written by Franklin H. Wentworth and published by the National Fire Protection Association (87 Milk St., Boston, Mass; price 10c.). Lessons from the fire are, of course, drawn. A folding map and a few halftone views are included.

A table for estimating the cost of joints in 4- to 48-in. cast-iron pipe has been compiled for distribution by the Leadite Co., of Philadelphia, Penn. It shows for both lead and leadite the pounds of calking material required per joint, and the cost per joint, per foot of pipe and per mile of pipe. The quantities and costs given are based on American Water-Works Association standard

*22 High St., Burlington, N. J.

bell-and-spigot joints. The table has been printed on a 3x5-in. card, and although issued primarily for advertising purposes, will interest water-works men.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ABWASSERREINIGUNGSANLAGEN IHRE LEISTUNGEN UND IHRE KONTROLLE VOM CHEMISCH-PRAKTISCHEN STANDPUNKT—Von Prof. Dr. K. Thumm, Abteilungsvorsteher an der Königl. Landesanstalt für Wasserhygiene in Berlin-Dahlem. Berlin: August Hirschwald. Paper; 6x9 in.; pp. 92. 2.80 Marks.

ADDENDUM, BEING THE FIVE CHAPTERS ON MODERN ROAD CONSTRUCTION Reprinted from "Asphalts" 1914 Road Edition—By T. Hugh Boorman. New York: The William T. Comstock Co., 23 Warren St. Paper; 7x10 in., pp 169-191; illustrated. 25c. if sold separately; incorporated in new edition of book, price of which is $2.

AIR-BRAKE CATECHISM; The Only Practical and Complete Work Published. Treating on the Equipment Manufactured by the Westinghouse Air Brake Company, Including the ET Locomotive Brake Equipment; the K (Quick-Service) Triple Valve for Freight Service; the Type L High-Speed Triple Valve; the P C Passenger-Brake Equipment, and the Cross Compound Pump, The Operation of All Parts of the Apparatus Is Explained in Detail, and a Practical Way of Finding Their Peculiarities and Defects with a Proper Remedy Is Given—By Robert H. Blackell. Entirely revised to date. New York: The Norman W. Henley Publishing Co. Cloth; 4x7 in.; pp. 411; 159 illustrations. $2.

AMERICAN MACHINISTS' HANDBOOK and Dictionary of Shop Terms: A Reference Book of Machine Shop and Drawing-Room Data, Methods and Definitions—By Fred H. Colvin, M Am. Soc. M. E., Associate Editor of the "American Machinist"; author of "Machine Shop Arithmetic," "Machine Shop Calculations," "American Machinists' Grinding Book," "The Hill Kink Books," etc., and Frank A. Stanley, M. Am. Soc. M. E., Associate Editor of the "American Machinist"; author of "Accurate Tool Work," "Automatic Screw Machines," "American Machinists' Grinding Book," "The Hill Kink Books," etc. Second edition, thoroughly revised and enlarged New York and London: McGraw-Hill Book Co. Leather; 4x7 in.; pp. xxvi + 673; numerous illustrations $3

FLIGHT WITHOUT FORMULAE: Simple Discussions on the Mechanics of the Aëroplane—By Commandant Duchêne, of the French Génie; author of "The Mechanics of the Aëroplane" Translated from the French by John H. Ledeboer, Editor, "Aëronatics"; joint-author of "The Aëroplane". New York and London: Longsmans, Green & Co. Cloth; 6x9 in.; pp. 211; 84 text figures. $2.25, net.

GASEOUS IMPURITIES IN THE AIR OF RAILWAY TUNNELS—By Atherton Seidell and Philip W. Meserve. Hygenic Laboratory, Bulletin No. 92. Washington, D. C.: United States Public Health Service. Paper; 6x9 in.; pp. 47; illustrated.

GEOLOGICAL AND TOPOGRAPHICAL MAPS, THEIR INTERPRETATION AND USE: A Handbook for the Geologist and Civil Engineer—By Arthur R. Dwerryhouse, Lecturer in Geology in the Queen's University of Belfast. London: Edward Arnold. Cloth; 6x9 in.; pp. 133; 90 text figures . $1.25, net.

DAS GRUNDWASSER, SEINE ERSCHEINUNGSFORMEN, BEWEGUNGSGESETZE UND MENGENBESTIMMUNG—Von Dr.-Ing. O. Smreker. Leipzig and Berlin: Wilhelm Engelmann. Paper; 8x11 in.; pp. 67; 27 text figures. 3.20 Marks.

LINK MOTIONS, VALVE GEARS AND VALVE SETTING: A Practical Treatise Which Explains the Mysteries of Valve Setting. Shows the Different Valve Gears in Use, How They Work and Why. Piston and Slide Valves of Different Types are Illustrated and Explained—By Fred H. Colvin, Associate Editor "American Machinist." Third edition, revised and enlarged. New York: Norman W. Henley Publishing Co. Cloth; 4x6 in.; pp. 101; 45 text illustrations. 50c.

METHODS OF MACHINE SHOP WORK, for Apprentices and Students in Technical and Trade Schools—By Frederick A. Halsey, M. Am. Soc. M. E., author "Slide Valve Gears," "The Use of the Slide Rule," etc. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 279; illustrated; $2.50, net.

MODERN PRACTICE IN MINING—Vol. III, Methods of Working Coal—By R. A. S. Redmayne, M. Inst. C. E., M. Inst. M. E., His Majesty's Chief Inspector of Mines; Late Professor of Mining in the University of Birmingham. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. xii + 210; 166 illustrations. $2, net.

PRACTICAL CALCULATIONS FOR ENGINEERS, [illegible] the Use of Engineering Students, Apprentices, Mechanics, Foremen, Draftsmen, and Others Practically Engaged in Engineering Work—By C. E. Larard, M. Inst. C. E., M. I. Mech. E., Head of the Mechanical Engineering Department at the Northampton Institute, London, and H. A. Golding, Assoc. M. I. Mech. E. Third edition, revised. London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. xii + 387; [illegible] illustrations. $2, net.

PRACTICAL RATE MAKING AND APPRAISEMENT—By William D. Marks, author of the "Finances of Gas and Electric Light and Power Enterprises, 1900" and of Other Technical Papers and Works. South Hadley, Mass.: Office, Presidents House. Cloth; 5x8 in.; pp. 269. $2, postpaid.

PROCEEDINGS OF THE SEVENTH SANITARY CONFERENCE OF THE HEALTH OFFICIALS OF CONNECTICUT—Held at New Haven, Mar. 26, 1914. Hartford, Conn.: State Board of Health. Paper; 6x9 in.; pp. 81.

A PUBLIC HEALTH SURVEY OF TOPEKA—A Report by Franz Schneider, Jr., Sanitarian, to the Topeka Improvement Survey, May, 1914. An Inquiry into Social and Living Conditions in the City of Topeka Made for the Purpose of Basing a Program of Community Advance upon the Facts of Local Problems; Under the Direction of the Department of Surveys and Exhibits, Russell Sage Foundation, 130 East 22d St., New York City. Paper; 6x9 in.; pp. 98; illustrated.

RAHMENFORMELN: Gebrauchsfertige Formeln für einhüftige, zweistielige, dreieckförmige und geschlossene Rahmen aus Eisen- oder Eisenbetonkonstruktion nebst Anhang mit Sonderfällen teilweise und ganz eingespannter Träger—Von Dr.-Ing. A. Kleinlogel, Privatdozent an der Techn. Hochschule Darmstadt. Berlin: Wilhelm Ernst und Sohn Paper; 7x10 in. pp x + 351; 338 illustrations. 11 Marks.

THE RAILWAY LIBRARY, 1913—A Collection of Noteworthy Addresses and Papers, Mostly Delivered or Published During the Year Named. Compiled and edited by Slason Thompson, Director of Bureau of Railway News and Statistics, Railway Exchange Bldg., Chicago, Ill. Cloth; 6x9 in.; pp. 469; illustrated. 50c.

RECENT COPPER SMELTING—Edited by Thomas T. Reed. San Francisco, Calif.: Mining and Scientific Press. London: The Mining Magazine. Cloth; 6x9 in.; pp. 459; 92 illustrations. $2.50.

REPORT OF THE SPECIAL BOARD OF CONSULTING ENGINEERS TO THE DAYTON FLOOD PREVENTION COMMITTEE (Mar. 26, 1914)—Dayton, Ohio: Dayton Citizens' Relief Commission. Paper; 7x10 in.; pp. 28

REPORT TO THE MERSEY & IRWELL JOINT COMMITTEE (May, 1914)—By Hugh Stowell, M. Inst. C. E., Chief Inspector, 44 Mosley St., Manchester, England. Paper; 6x9 in.; pp. 37.

Besides reviewing the river inspection work of two years, this report contains tabular information regarding the large number of sewage-treatment works in the Mersey and Irwell drainage areas.

ROBERTS-AUSTEN: A RECORD OF HIS WORK—Being a Selection of the Addresses and Metallurgical Papers, Together with an Account of the Researches, of Sir William Chandler Roberts-Austen, Hon. M., Inst. C. E., Inst. Mech. E., Inst. M. & M., Am. Inst. M. E., Late Chemist and Assayer of the Royal Mint; Professor of Metallurgy in the Royal School of Mines; author of "An Introduction to the Study of Metallurgy," and Editor of Griffin's Metallurgical Series. Compiled and edited by Sydney W. Smith, Assistant Assayer at the Royal Mint. London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 6x9 in.; pp. x + 382; portrait and 23 plates. $6, net.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMÉRIQUES; de Chimie, de Physique et de Technologie. Vol. III, Année 1912. Publiées sous le patronage de l'Association internationale des Académies par le Comité international nommé par le VIIe Congrès de Chimie appliquée (Londres, 2 juin 1909). Paris (VIe): Ch. Marle, Secrétaire général du Comité international, 9, rue de Bagneux. Cloth; 8x11 in.; pp. xlix + 595. American Agents: The University of Chicago Press.

TASCHENBUCH FÜR BAUINGENIEURE—Herausgegeben von Max Foerster, Geh. Hofrat, ord. Professor an der Technischen Hochschule in Dresden. Second edition. In two parts. Berlin: Julius Springer. Cloth; 5x8 in.; pp. xvi + 2078; 3054 text figures. 20 Marks.

TASCHENBUCH FÜR DEN MASCHINENBAU—Herausgegeben von Ing. H. Dubbel. Berlin: Julius Springer. In two parts. Cloth; 5x8 in.; pp. xi + 1482; 2448 text figures and 4 tables. 16 Marks.

U. S. BUREAU OF THE CENSUS—Washington, D. C. Cloth; 9x12 in.

Population, 1910: Thirteenth Census of the U. S., Vol. IV., Occupation Statistics. Pp. 615.

Financial Statistics of Cities Having a Population of Over 30,000: 1912. Pp. 410.

UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.

Quality of the Surface Waters of Washington—By Walton Van Winkle. Water-Supply Paper 339. Pp. 105.

The Production of Mineral Waters in 1913, with a Discussion of Their Radioactivity—By R. B. Dole. (Mineral Resources of the United States Calendar Year 1913—Part II. Pp. 393-440.)

The Transportation of Débris by Running Water—By Grove Karl Gilbert. Based on Experiments Made with the Assistance of Edward Charles Murphy. Professional Paper 86. 9x12 in.; pp. 259.

VORLESUNGEN ÜBER WASSERKRAFTMASCHINEN—Von Dr. Phil. Dr.-Ing. R. Camerer, Dipl.-Ing. O. Professor des Maschinenbaues an der Kgl. Techn. Hochschule, München. Leipzig and Berlin: Wilhelm Engelmann. Cloth; 7x10 in.; pp. xxvii + 577; 718 text figures and 55 tables. 25 Marks.